DVB-T channels measurements for the deployment of outdoor REM databases

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***Abstract*—The goal of this work is to discuss the stability and other important features of the observed spectrum occupancy in the context of outdoor Radio Environment Maps database deployment. Reliable deployment of these databases seems to be one of the critical points in practical utilization of the TV White Spaces for cognitive purposes inside buildings and in densely populated cities. The results obtained for outdoor scenario are briefly compared with the previous measurements conducted indoors in Barcelona, Spain, and in Poznan, Poland.**

I. Introduction

In this work we concentrate on the analysis of the measurement results obtained during the campaigns performed during the NEWCOM# project lifetime in two European cities, i.e. Poznan in Poland and Barcelona in Spain, particularly focusing on the drive-tests conducted in Poland. Some of the results have been already presented in the prior work of the authors [1]-[2], and particularly in [3], as this work is an extension of it. In this paper, however, we have extended the observation focusing mainly on the measurements obtained during the drive tests.

II. System setup

The two street measurement campaigns, described in this paper, have been conducted in Poznan, Poland, whereas the indoor measurements (used in this work for comparison purposes) have been also carried out in Barcelona, Spain. The measurement devices have been setup as follows:

a) *for the indoor/outdoor measurements*
In the case of indoor/outdoor measurements in both cities the DVB-T signal was captured by an omnidirectional antenna, which transfers it to a spectrum analyzer for initial data processing. Then the measured samples have been stored on the portable computer with the use of appropriate Matlab toolbox. In case of Poznan measurements active quad antenna, covering 40-850MHz (1-69TV channel), was connected via coaxial cable Lexton 3C2V of length 3m to the R&S FLS6 spectrum analyzer. In Barcelona scenario a passive discone antenna of type AOR DN753 was used, covering the frequency range from 75 to 3000MHz, and connected to ANRITSU MS2721B device. In both setups the resolution and video bandwidth of the spectrum analyzers were the same and equal to RBW=30kHz and VBW=100kHz, respectively.

b) *for the drive-tests*
In the case of street measurements the omnidirectional discone antenna AOR DA753 has been attached to the rooftop of a car. The aerial was connected to Rohde&Schwarz FSL v6 spectrum analyzer via low loss H155 cable. The spectrum analyzer was previously equipped with a card allowing for powering it from direct current (DC) source, i.e. lighter socket. The spectrum analyzer was connected (as in previous, indoor setup) via Ethernet cable to a laptop that runs Matlab with Instrumental Control Toolbox installed. Additionally, GPS receiver was placed on the top of the car and connected via USB cable to the laptop. It allowed us obtaining, for each measured frequency point, the exact geographical location of the measurement. As previously, RBW and VBW was set to 30kHz and 100kHz, respectively.

The measurements paths were made for the first time around Poznan city center in normal traffic conditions during daytime in October 2013. The second one has been realized in analogous conditions (i.e. normal traffic conditions during daytime) but late winter, precisely February 2014.

III. Measurement Results

A. Drive Tests

First, let us analyze the achieved results from the drive test, which are presented in form of the received power in the selected DVB-T channels (23, 27, 36, 39, see Table I) expressed in dBm per 8 MHz as the function of the distance from the start of the route and as the function of time from the measurement beginning

The received signal power as the function of the distance from the route start for the first measurement campaign is presented in Fig. 1.

Let us analyze the averaged Power Spectral Density of the received signal (Fig. 2 for the Route 1[1]). In this figure the presence of four high-power DVB-T signals are observable at channels 23, 27, 36 and 39. The figure illustrates three

[1]In this extended abstract we show only the results for the first route, all obtained results will be shown in the full version of the publication

TABLE I. List of scanned TV channels

TV channel	Frequencies [MHz]	Carrier Frequency [MHz]
23	486-494	490
27	518-526	522
36	590-598	594
39	614-622	618

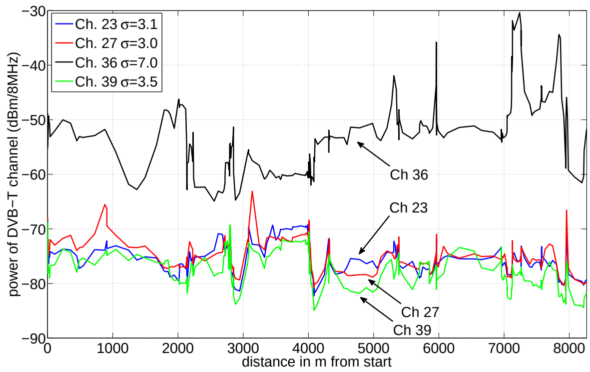

Fig. 1. Received signal power as the function of the distance from the route start - Route 1

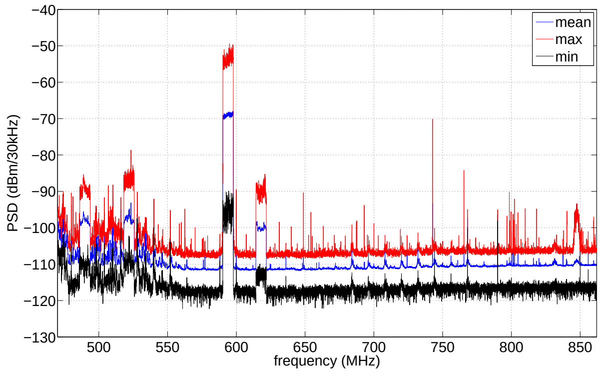

Fig. 2. Power Spectral Density Function of the received signal samples during the whole drive test - Route 1

curves: the received power averaged during the whole route (middle plot, blue one), minimum observable power during the whole route (bottom plot, black one), and maximum observed power during the whole measurement time (upper plot, red one). Since the raster on the horizontal axes is 30kHz, one can observe that relatively high number of narrowband peaks are observable in various locations. It is also worth noticing that the two lower channels 23 and 27 in some locations are not detectable or at least severely degraded, since the received power in that band is close to the ambient noise power.

B. Indoor-Outdoor measurements

As the detailed analysis of the performed measurements inside buildings of Poznan and Barcelona has been presented in [1]-[2], let us now focus on the comparison between the street measurements (drive-tests) and the selected results observed by both stable (non-moving) roof-antennas and the antennas located inside buildings in the UPC campus. The exemplary results obtained in Barcelona using stable (non-moving) measurement equipment are presented in Tables II to IV.

IV. Conclusions

In this paper the comparison of the measurement results of the two street drive-tests will be presented and compared with

TABLE II. Received signal power observed at Channels 26 and 61 expressed in [dBm/8MHz] - in Barcelona

	CH 26	CH 61
Outdoor Reference	-51,27	-52,18

TABLE III. Received signal power at channel 26

Ch. 26	A	B	C	Avg	Att.
Under ground	-68,19	-70,41	-74,39	-69,25	17,98
Ground floor	-69,75	-60,39	-70,77	-63,49	12,22
1st floor	-56,53	-54,34	-65,85	-57,85	6,58
2nd floor	-55,72	-56,02	-61,60	-57,60	6,33

TABLE IV. Received signal power at channel 61

Ch. 61	A	B	C	Avg	Att.
Under ground	-79,28	-82,47	-82,35	-80,69	28,51
Ground floor	-68,43	-66,01	-73,91	-68,47	16,29
1st floor	-62,26	-60,60	-72,96	-64,08	11,90
2nd floor	-67,79	- 57,89	-73,56	-63,18	11,00

the indoor measurements done in two European cities, focusing on the similarities and differences that occur between indoor measurements and drive tests. It has been stated that hopefully in both scenarios the stability of the TV channels is very high, and the influence of the surrounding moving objects is rather limited. Such an observation is crucial, since it is the basis for further work on the deployment of local outdoor and indoor radio environment maps for TV White Space Communications.

Acknowledgements

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References

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