

6th Meeting of SE43

BNetZA, Mainz, 15-17 June, 2010

Date issued: 14 June, 2010

Source: ECO

Subject: Initial results of the SEAMCAT simulations using new CRS module

Password protection required? (Y/N)	N
-------------------------------------	----------

Summary:	This document provides initial results of simulations using Monte Carlo tool (beta version (3.2.1 beta 4) (www.seamcat.org/betaversion)) on the compatibility between CRS operating in the white spaces in the frequency band 470-790 MHz and Broadcasting service.
Proposal:	SE43 is invited: <ul style="list-style-type: none"> - to consider presented document; - to advice on the chosen scenarios and assumptions.
Background:	<p>With spectrum sensing, the interfering devices (i.e. It) try to detect the presence of protected services (i.e. the Wt) in each of the potentially available channels. Spectrum sensing essentially involves conducting a measurement within a candidate channel, to determine whether any protected service is present and transmitting. When a channel is determined to be vacant, sensing is typically applied to adjacent channels to determine what constraints there might be on transmission power, if any.</p> <p>A key parameter for spectrum sensing is the detection threshold that is used by a cognitive device to detect the presence or the absence of a protected service's transmission. If it detects no emission above this threshold, the white space device (WSD, i.e. the It) is allowed to transmit, otherwise the WSD keeps silent.</p>

1. Introduction

SEAMCAT allows studying this phenomenon with its new implementation of the algorithm developed with involvement of SE43 members. SEAMCAT enables multiple

cognitive radio (CR) systems. The CR feature mainly introduces the detection threshold and the selection of the operating frequency of the WSD.

STG at its May 2010 meeting endorsed proposed algorithm enabling simulation of the sensing feature employed by the cognitive technology. SEAMCAT beta was deployed by the Office at the end of May. These preliminary results are generated from the version 3.2.1 Beta 7.

Algorithm used for the simulations is described in details at the following web-page: <http://seamcat.iprojects.dk/wiki/Manual/Scenario/CRS>

2. Methodology

Simulations were conducted using SEAMCAT tool. The objective of the Monte-Carlo simulations was to determine probability of interference due to unwanted effect to the victim DTT receiver.

Parameters used for the simulations were extracted from the draft ECC Report on technical and operational requirements for the operation of cognitive radio systems in the ‘white spaces’ of the frequency band 470-790 MHz and can be found in the section 3 below.

Extended Hata and JTG 5-6 propagation models were considered for the purpose of the study.

In order to determine probability of interference mode “relative positioning of interfering link” so called “None” was chosen. This means that n_{active} interfering transmitters are located in a circular area with a simulation radius (sim. radius = 31 km). The random placement of the interfering transmitters in this area is defined by the path azimuth (0; 360) and the path distance factor parameters (equal = 1).

The interference probabilities for unwanted and blocking effects are determined in the following way:

SEAMCAT checks if the calculated ratio is greater than C/I then

- if yes then this event is considered as “good” one;
- if not then this event is considered as “interfered” event.

Interference criterion $C/I = 20$ dB was considered in the calculations (in accordance with draft ECC Report).

The document considers case of the DTT fixed reception in rural environment which is similar to the Configuration 3 presented in the Table 4.3 of the draft ECC Report on technical and operational requirements for the operation of cognitive radio systems in the ‘white spaces’ of the frequency band 470-790 MHz.

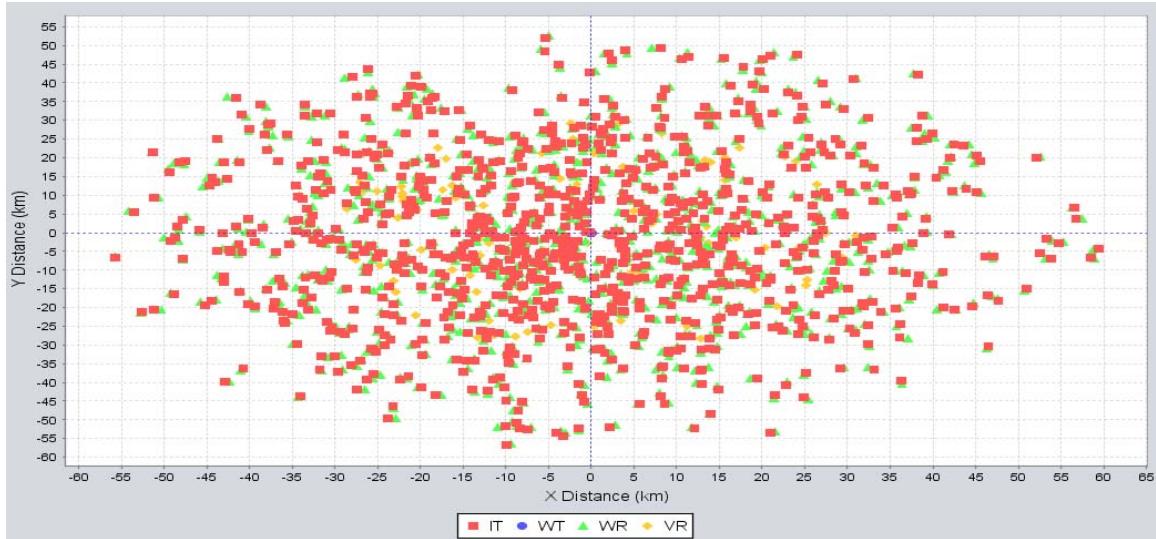


Figure 1. SEAMCAT outline of the considered scenario

3. Assumptions and scenarios

Frequency of victim DTT receiver in our example is in the upper part of the UHF frequency range: 710 – 790 MHz.

- 10 active WSD were considered in the calculations.
- WSDs are located in the coverage area of the DTT transmitter;
- the E.I.R.P max in-block power is defined in order to prohibit co-channel transmission.
- Spectrum mask for DVB-T transmitter is taken from the ECC Report 004 on initial ideas concerning the revision of the Stockholm (1961) Agreement.
- Extended Hata and JTG (Joint Task Group) 5-6 propagation models were considered.

Following parameters were considered in the simulations:

- Victim frequency is in the range 710 – 790 MHz.
- Transmitter spectrum mask for DVB-T is taken from the ECC Report 004 on initial ideas concerning the revision of the Stockholm (1961) Agreement (Figure 4.1 of the Technical Annex).

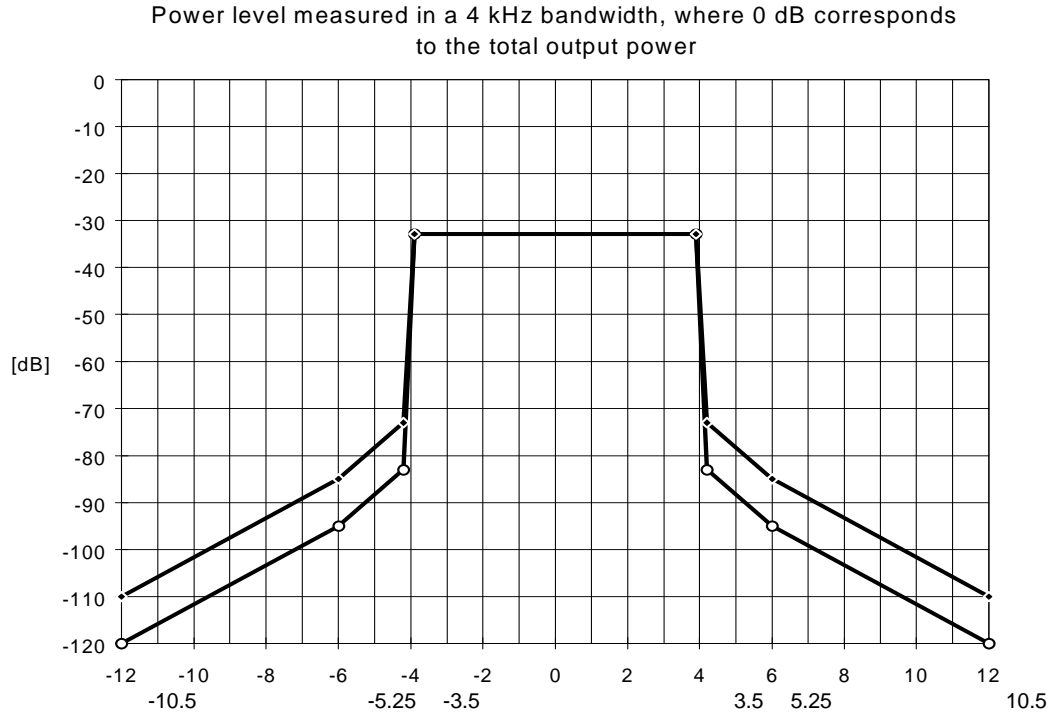


Figure 2. Frequency relative to centre of DVB-T channel {MHz}
 upper scale: 8 MHz channel, lower scale: 7 MHz channel
 upper curve: non-critical cases, lower curve: sensitive cases

8 MHz channels	
Relative Frequency MHz	Non-critical case
	Relative Level dB
-12.0	-110.0
-6.0	-85.0
-4.2	-73.0
-3.9	-32.8
+3.9	-32.8
+4.2	-73.0
+6.0	-85.0
+12.0	-110.0

Table 1: Breakpoints used in the Transmitter spectrum mask for DVB-T

- DVB-T parameters used in the compatibility study is taken from the Table 4.1 (second column) of the Draft ECC Report on technical and operational requirements for the possible operation of cognitive radio systems in the ‘White Spaces’ of the frequency band 470-790 MHz.
- *Can STB/iDTV type* of DVB-T receiver is used to define blocking mask (“protection ratio” mode) was chosen in SEAMCAT simulations (Table 7a of Annex A to the draft ECC Report).

Channel edge separation (MHz)	PR (dB)								
	10th			50th			90th		
	Can STB/iDTV	Silicon STB/iDTV	Silicon USB	Can STB/iDTV	Silicon STB/iDTV	Silicon USB	Can STB/iDTV	Silicon STB/iDTV	Silicon USB
co-channel	13 ... 18	13 ... 18	NA	18 ... 19	18 ... 19	NA	20 ... 22	19 ... 22	NA
1.5	-28 ... -14	-15 ... -14	-28	-24 ... -13	-14 ... -14	-23	-21 ... -12	-13 ... -13	-18
9.5	-53 ... -51	-52 ... -51	-43	-48 ... -46	-49 ... -42	-37	-44 ... -42	-46 ... -32	-31
17.5	-56 ... -54	-55 ... -52	-45	-48	-51 ... -43	-39	-43 ... -40	-47 ... -34	-32
25.5	-64 ... -57	-57 ... -56	-47	-61 ... -56	-52 ... -46	-39	-58 ... -56	-47 ... -35	-31
33.5	-70 ... -56	-58 ... -55	-49	-67 ... -55	-54 ... -45	-40	-63 ... -55	-50 ... -36	-31
41.5	-73 ... -55	-59 ... -53	-49	-77 ... -54	-52 ... -45	-40	-62 ... -54	-45 ... -37	-31
49.5	-76 ... -57	-60 ... -57	-49	-74 ... -56	-56 ... -48	-40	-69 ... -55	-51 ... -39	-30
57.5	-77 ... -59	-63 ... -56	-49	-72 ... -58	-55 ... -46	-40	-63 ... -58	-48 ... -36	-30
65.5	-58 ... -54	-63 ... -53	-47	-46 ... -43	-55 ... -45	-40	-39 ... -30	-46 ... -37	-32

Table 2.: DVB-T PR values in the presence of a LTE-UE interfering signal without TPC in a Gaussian channel environment at the 10th, 50th and 90th percentile: comparison between can-tuners and silicon-tuners

- EIRP in-block mask for cognitive radio devices is taken from the SE43(10)18 and is shown in Figure 2.

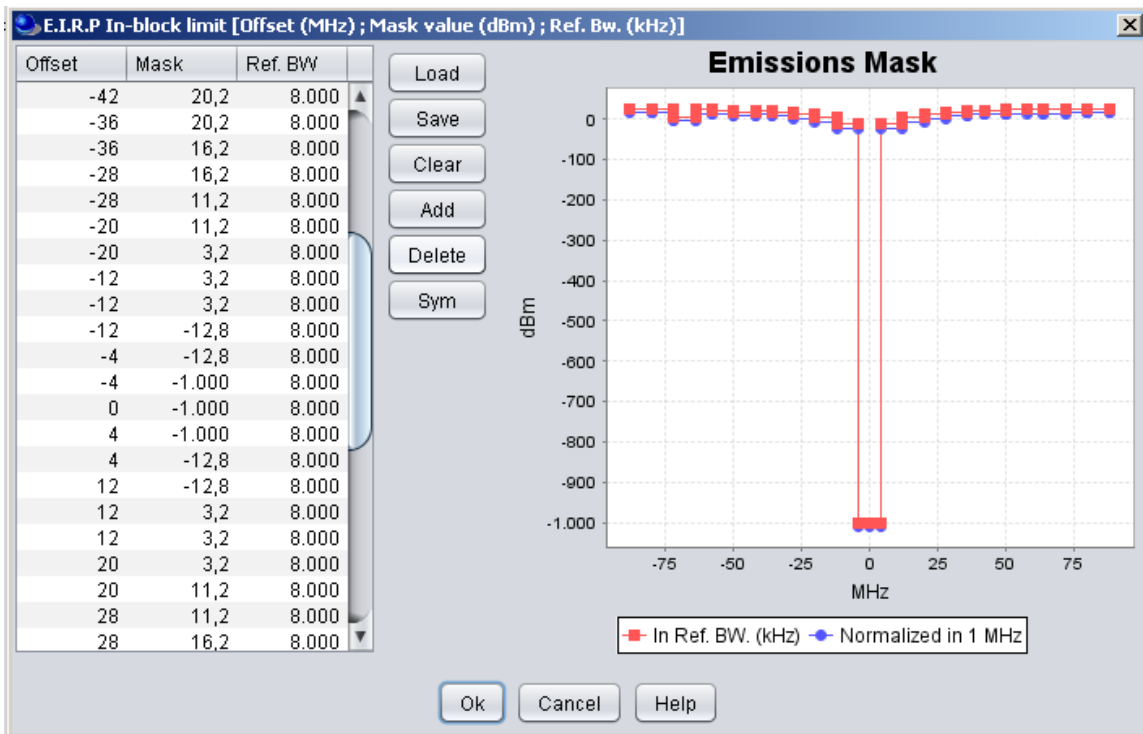


Figure 3. EIRP in-block limit set in SEAMCAT

- Sensing detection threshold is -130 dBm.
- Hidden node margin is 0 dB.

- DVB-T Tx height is 100m, DVB-T Rx height is 10m
- Interference transmitter height is 1.5 m, WR = 30 m.
- 10 active WSD transmitters were considered in the simulations.
- Following propagation models are considered for the study:
 - For DVB-T victim link (Wt to Vr path) – the JTG5-6 model developed in SE42 with the following assumptions (Tx antenna heights: 30 m to 200 m and Rx antenna heights: 1.5 m to 10 m, 1% time probability and a clutter height of 10 dB) Further details on the JTG 5-6 can be found at <http://seamcat.iprojects.dk/wiki/Manual/PropagationModels/JTG56>; Use of the plugin: JTG56_ver2 (embedded in the workspace);
 - For Interfering system link (It to Wr path) – Extended Hata;
 - For Interference link (It to Vr path) – Extended Hata;
 - For Sensing link (Wt to It path) – Extended Hata.

Note that with the current assumption of the JTG5-6, it is possible to use it only for the victim link because the Tx height of the interfering transmitter is below 30 m.

- OoB Mask of the It for LTE UE (10 MHz) was considered for the study (from ECC Report 150 (under PC by WGSE)):

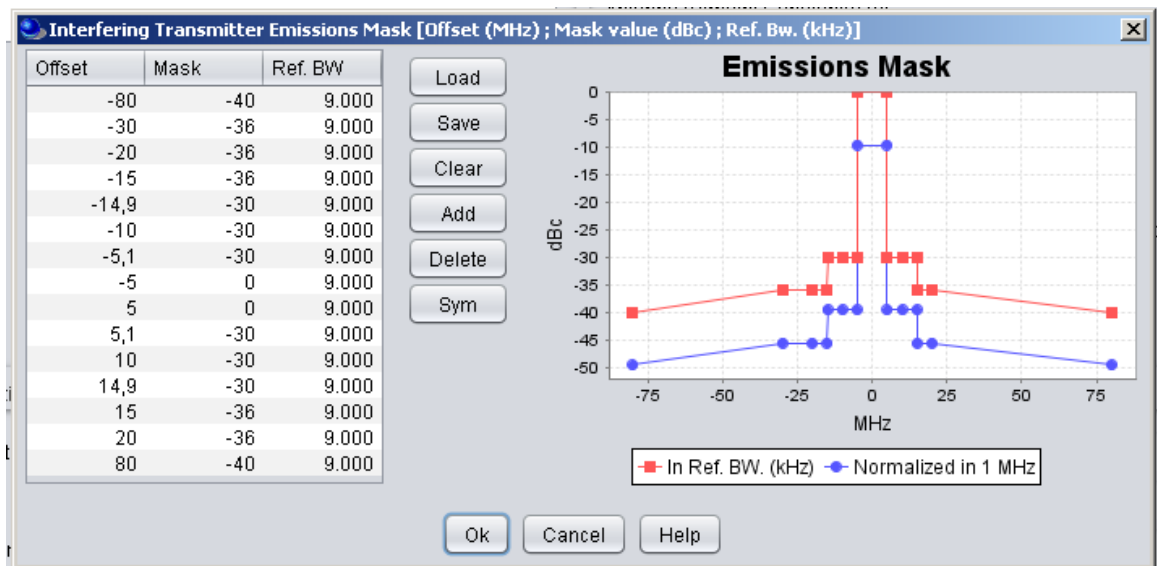


Figure 4. It emission mask is set in SEAMCAT

4. Preliminary results

Initial results of the compatibility study has shown that when considered co-coverage and adjacent channel scenario interference probability due to unwanted emissions is 0% and due to blocking effect is 0 % (20000 snapshots where simulated).

See attached workspace (note that the plugin is embedded in the workspace)

<workspace removed and revised to the on-line manual
<http://seamcat.iprojects.dk/wiki/Manual/Scenario/CRS>>

Figures 5 and 6 illustrate average e.i.r.p. per event per active WSDs and average active WSD per event (20000 snapshots).

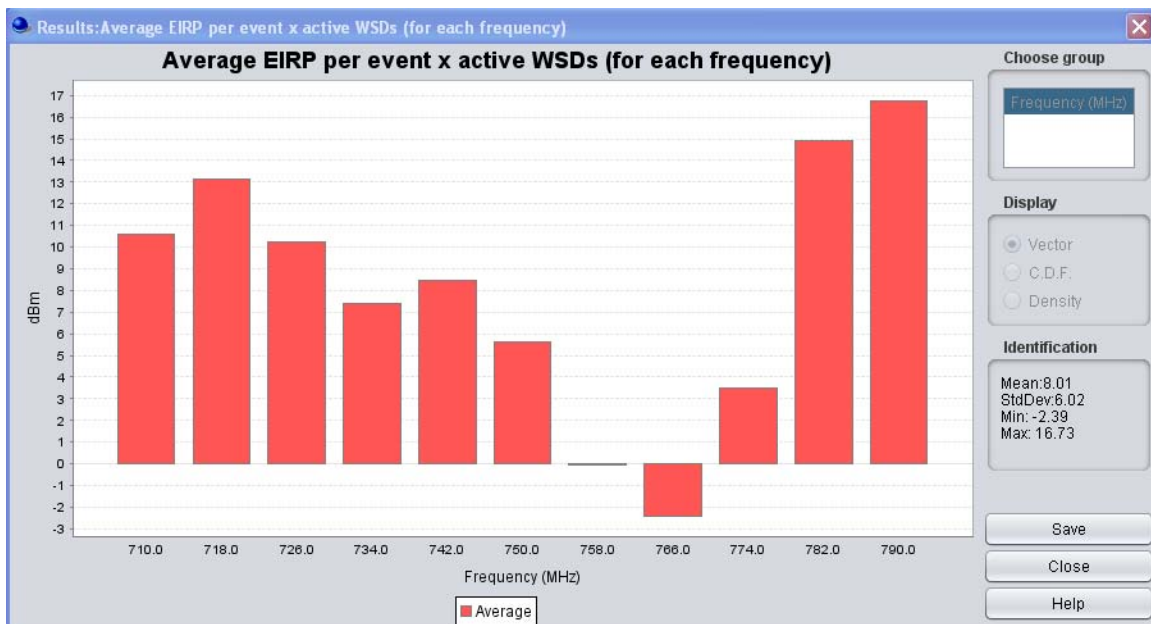


Figure 5. Average e.i.r.p. per event per active WSDs operating at each frequency.

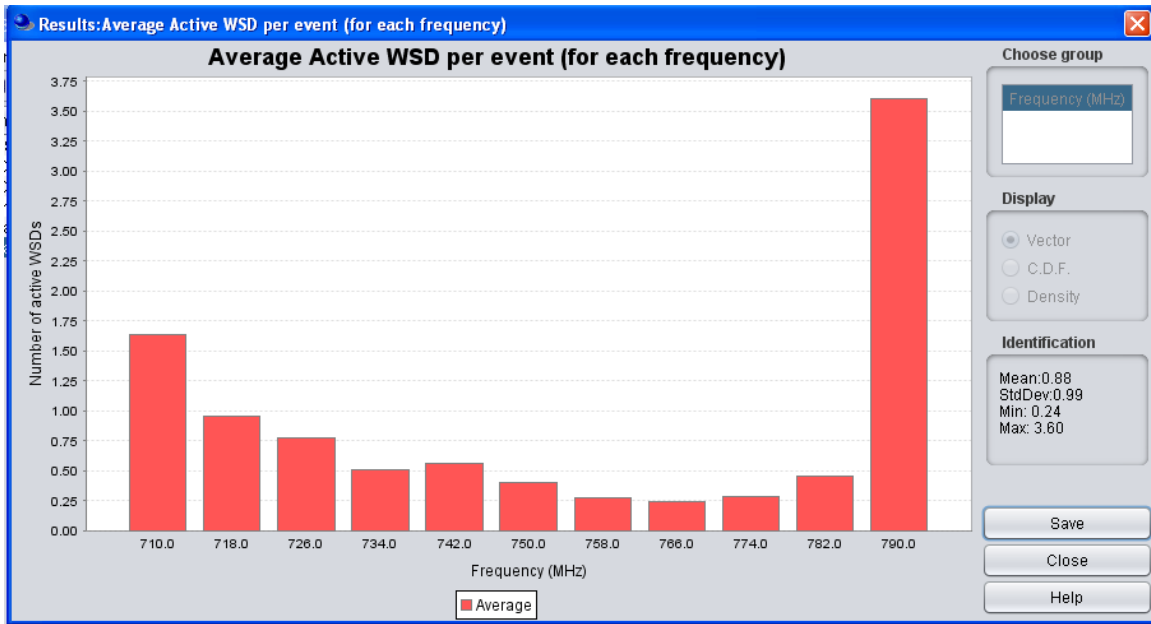


Figure 6. Average active WSD per event operating at each frequency.