ATDI

WSD management

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1. Introduction

TV White Spaces (TVWS) are vacant frequencies made available for unlicensed use at locations where spectrum is not being used by licensed services. This band is currently used by Digital Terrestrial Television (DTT) and Program Making and Special Events (PMSE) users.

The following document is a contribution to the introduction of the White Space Device (WSD) service in the DTT frequency band.

It is also presenting how to build, use and share a WSD database from calculations and analysis made with ATDI platform.

Figure 1: The UHF TV band (470-790 MHz) and its users

2. Approach to build a WSD national database

ATDI suggest performing the following tasks in order to build the WSD national database:
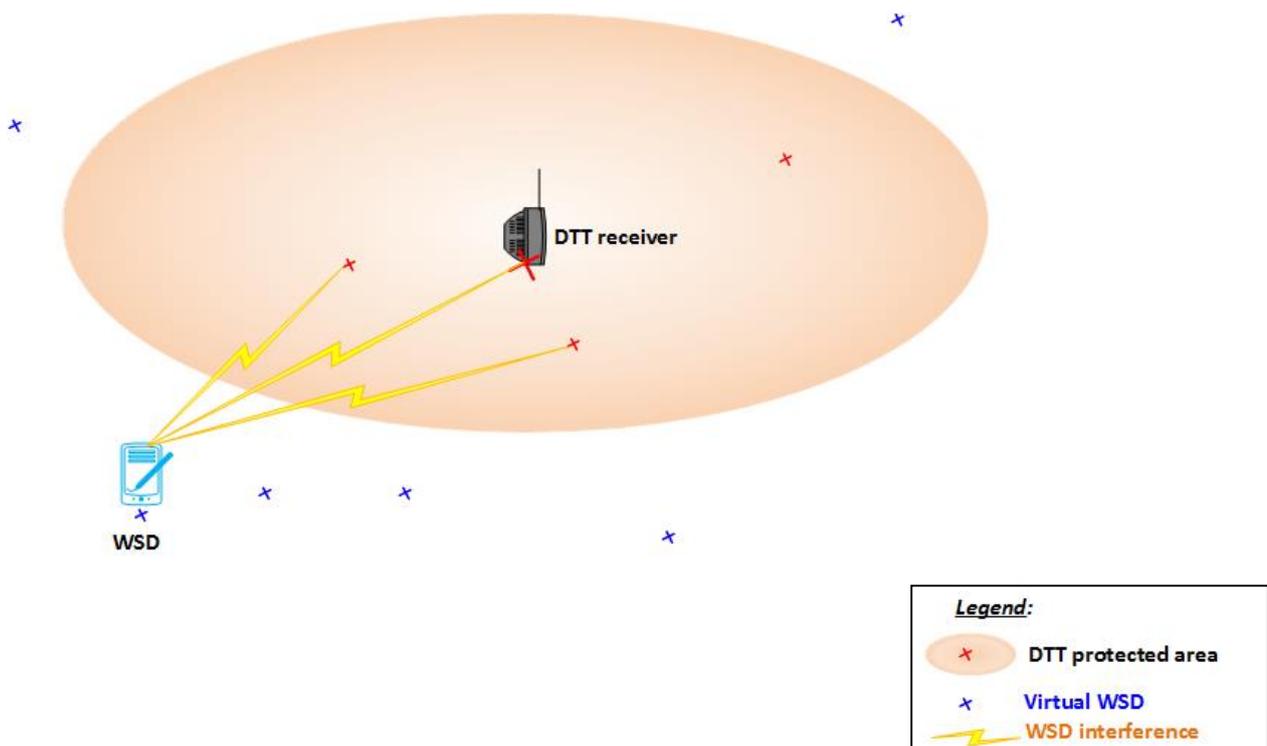
Figure 2: Approach to build a WSD national database

28.05.14

a) **Coverage calculation of all DTT networks.** A reference propagation model has to be defined and must be reversible in order to be used also to check compatibility with WSD transmitters.

b) **Foreign DTT transmitters should also be taken into account.** A strategy to protect foreign transmitters (assignments and allotments) must be defined based on threshold and/or coverage calculation.

c) **Definition of PMSE** properties areas, dedicated channels…

d) **Define possible reserved DTT channels** (for possible future multiplex).

e) **Check coverage** and apply filter on populated areas using a population database.

f) **Calculation of TVWS availability map** using **interference** calculations from WSD on DTT receivers to define exclusion areas. Calculations are made for a delta frequency up to N+/-3 (according to ETSI EN 301 598 V1.0.0) and out of band, for each WSD class, for each DTT channel and for different WSD antenna height. A noise margin can be applied in order to consider multiple WSD transmitting from the same point.

g) **Make free spectrum maps** available for online consultation (showing the number of available channels on each point) with the following information: Coordinates of each point, channels available and associated **maximum power allowed**.

i) **With the addition of number of new WSDs**, interference levels need to be checked again with power sum of interference from new WSDs added to the DTT interference.

j) **The WSD authorization strategy** has also to be clearly defined: constraints by services, provisioning, priority…

k) **Definition of authorized WSD protocols** (Open White-Spaces) for distant router start-up and monitoring (QoS, Traffic).

3. Method overview for TVWS Calculations

The white space is part of the spectrum, which is available for applications of radio-communication (service, system) in the UHF 470-790 MHz bands, as shown in the figure 1 above.
The main aim is to place WSD in coverage gaps of TV channels. The method consists on identify areas of availability of each TV channels.

To validate or invalidate the authorization, the method is detailed in the figure below. The platform contains three key units:

- A TVSW Calculation tool

- A management tool database.
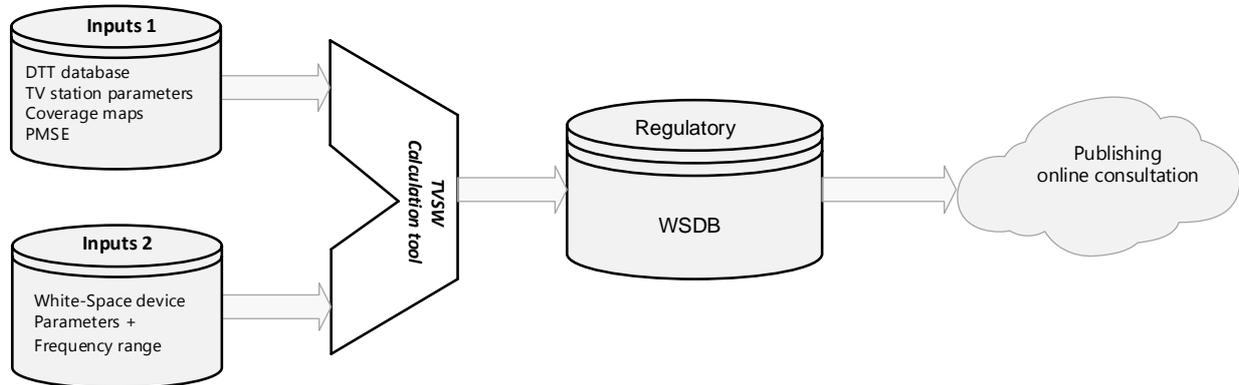
- A publishing tool or a dedicated Web site.

Figure 3: Platform overview for WSD management

4. Implementation of TVSW calculation

4.1. TVSW Calculation tool

A radio planning tool will calculate and estimate from the database of existing DTT stations, the channels available on each point in a given area.
The purpose is to protect these transmitters (assignments and allotments) against any harmful interference with a strategy based on the threshold and/or coverage calculation.

After this calculation, the necessary data is sent to backup and update the WSDBs for the next WSD requests.

The input data took into account in this calculation is: WSDs Parameters, Frequency range and ID.

4.1.1. Input data

The input data will concern all parameters required for the calculations and the determination of TV white Spaces. This data consists of:
- The DTT and PMSE transmitter database licensed with their transmission parameters, site locations, coverage already computed ...
- A request for WSD channel(s) with known the transmission parameters (power, dynamic range, frequency band ...).

4.1.1.1. Licensed stations database (DTT, PMSE)

This database contains all DTT stations and PMSE already allocated in a given area and at the national level. Thus, the characteristics (radiated power, coverage maps, location, frequencies, protection ratios,...) of each known transmitter (licensed) are available.

4.1.1.2. Unlicensed devices database (WSD)

The unlicensed WSD database (WSDB) contains the following information:
- Coordinates (longitude, latitude or X,Y) and antenna height or altitude of the master WSD.
- Antenna characteristics: power, gain, and polarization.
- Equipment class.
- The frequency band in which the WSD can operate.
This information will then be used to set up the calculation tool to perform the coverage of white space according to cartographic environment, propagation model, antenna height and clutter properties.

4.1.2. Proposed calculation method

The calculation tool based at the regulatory authority and will build the following:

- TVWS availability maps
- Areas to be protected for each DTT channel
- Assign channel(s) to WSD

These calculations are performed on each DTT channel. It will also be possible to compute the maximum allowed power for each channel and will depend on the equipment class.

4.2. Database management tool WSDB

The results issued by the calculation tool will be stored in the WSDB database that will contain maps of protected channels, available TVWS channels, the maximum **power allocated to each channel**. It will also register the WSD already authorized.
The regulation authority will define the way to access to this database and the available channels allocation process.
Online database management through a specific tool or a dedicated website will allow the sharing of the available channels according to the criteria defined by the regulator.

4.3. Online access

Once the WSDB database is populated, it can be shared online. This will allow WSD users/operators consulting information about available TVWS channels around a given area and make a formal request for the use of a given WSD channel knowing:

- The eligibility, qualifications and priority of WSD channels from the type and the class.
- The list of available channels and the maximum power allocated.
- The list of already used channels (permanently or temporary such as for some PMSE services for example).

It will be also possible to contact the database administrator to validate selected channels before using them.

This web platform will then allow the operators to merge all channels requests performed from the WSD online registration forms and periodically forward them to the regulation authority.

5. The regulation authority

In the context of WSD management, the regulation authority will define the settings to be considered in the calculation tool. A number of rules can be recommended in order to enhance the performance and accuracy of the calculations. These settings will allow among other to avoid harmful interference between DTT vs WSD.

Parameters to be considered:

- A reference propagation model .
- Coverage threshold and maximum distance calculation
- Protection ratios for each DTT channel.

The regulation authority will manage the database (maps of TVWS availability in given area, see figure 5) directly or indirectly through a" supra-operator". This supra-operator will be administrator of the WSDB. And will also have to define the terms for TVWS channels allocation. To do this the regulator may define a frequency allocation table also accessible online by users. The management of this table is entrusted to the operator.

		Protection Ratio C/I			
		PR1	PR2	PR3	PR4
Priority	N1	C11	C12	C13	C14
	N2	C21	C22	C23	C24
	N3	C31	C32	C33	C34
	N4	C41	C42	C43	C44

Figure 4: Example of channels allocation table (C_{NPR})

An available TVWS channel corresponds to both a priority level (N) and a protection ratio C/I (PR) given. For example, a service with lower priority may be allocated a frequency only if there are more than two channels available at this point. See figure 5 for an example of calculation of available TVWS in a given area.

6. ATDI TVSW Calculation platform

6.1. Overview

The rapid growth of connected devices across the world increases the demand for wireless spectrum. The rarity of these spectrum resources requires complete control of the spectrum already allocated in order to be able to redistribute and share it.
ATDI currently provides to regulators a platform to master the available spectrum.
Based on the method previously described, the architecture of the ATDI platform to manage TVWS is described below.

Figure 5: TVWS calculations and Management with ATDI tools

ICS telecom is the radio planning tool developed by ATDI and used by many regulators and operators across the world. This computing platform henceforth includes dedicated modules to calculate TVWS.

For example, a map made of 100.000km² at a resolution of 100m, the computing time is 15min per channel.

474 MHz - Max power level: 019 dBm
482 MHz - Max power level: 023 dBm
490 MHz - Max power level: 018 dBm
498 MHz - Max power level: 023 dBm
506 MHz - Max power level: 023 dBm
514 MHz - Max power level: 023 dBm
522 MHz - Max power level: 023 dBm
530 MHz - Max power level: 023 dBm
538 MHz - Max power level: 023 dBm
546 MHz - Max power level: 023 dBm
554 MHz - Max power level: 021 dBm
562 MHz - Max power level: 023 dBm
570 MHz - Max power level: 023 dBm
578 MHz - Max power level: 017 dBm
586 MHz - Max power level: 023 dBm
666 MHz - Max power level: 023 dBm
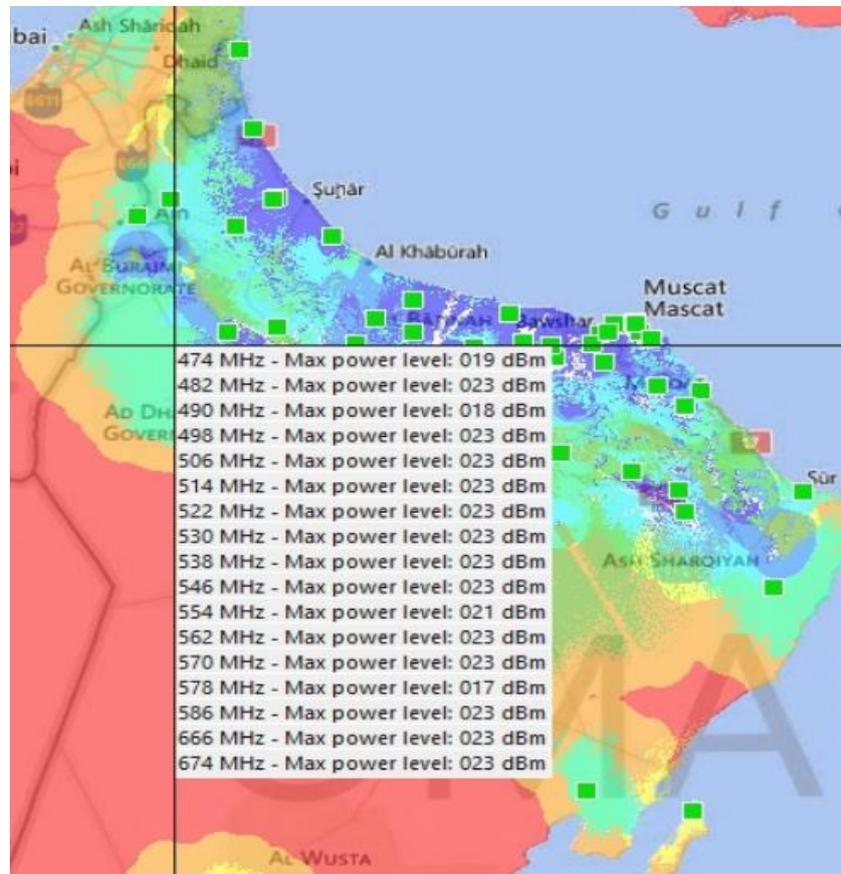674 MHz - Max power level: 023 dBm

Figure 6: Available channels with the corresponding maximum power

ATDI also recommends its management system database, ICS manager dedicated to regulators and radio spectrum managers. This tool allows the allocation and administration of channels by establishing rules.
ICS manager has an online service that allows sharing information with TVWS users. All these functions can be used for any type of technology.

6.2.   Advantages of ATDI method

The method recommended by ATDI allows to:
- Determine accurately the available TVWS channels.
- Allocate channels taking into account the security rules for protected areas.
- Analyse the impact of a new deployment WSD on other services in a given area.

For further information about the tools developed by ATDI for the calculation and management of TVWS you can visit our website:

http://www.atdi.com/white-space-device-calculation-and-database/

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