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*Contribution to WG3: Definition of network-wide mechanisms for
enabling the cognitive approach*

*Implementation of a Communication Protocol between a Geo-location
Database and TV White Space Devices*

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Television White Spaces (TVWS) are a spectral opportunity, for secondary users of the spectrum to deliver broadband access to rural areas. Most of the approaches now under test worldwide use a geo-location database to inform secondary users of the available channels, and avoid interference with primary users of the spectrum. The secondary network should follow a approach capable to communicate with a geo-location spectrum database, to store and retrieve information on spectrum occupancy, location of DVB-T broadcast towers and wireless microphones, maximum EIRP of secondary White Space devices (WSDs), sensing activity and other technical parameters. One group from the Internet Engineering Task Force (IETF) [1] is presently working on the definition of a protocol to access white spaces databases - PAWS [2]. The IETF draft protocol was chosen and considered flexible enough to be adapted for the CREW-TV project model and requirements, since it is more comprehensive and less specific on details than other proposals [3].

The purpose of this paper is to describe the implementation of a reliable and secure communication protocol for WSDs to access geo-location database services over the Internet. The remaining document present the proposed solution, followed by a description of the protocol requirement and implementation using a web-based environment.

The communication takes place between a geo-location database and a fixed base station (master WSD). The services are accessed by the master WSD using HTTPS GET and PUT requests over the Internet. Operations are only initiated by the WSD, with a response from the geo-location database. This eliminates the necessity of the geo-location database to initiate communications with the WSD.

We defined separate requirements for slave WSDs and master WSDs. The protocol must enable a master WSD to complete the following tasks:

- Connect to the database;
- Register with the database;
- Provide its geo-location and other data to the database;
- Receive in response to the query a list of currently available white space channels, maximum power and sensing requirements.

Moreover, the protocol should enable a slave WSD to complete the following tasks:

- Request to a master WSD, to verify if the slave WSD is valid (enrolled in the database);
- Receive in response to the query, a status code from the master WSD, indicating if the slave WSD is valid or not.

Services not considered in the current implementation, but defined in IETF PAWS, are:

- Database discovery;
- Master or slave WSDs enrolment in the database.

The contents of the queries and response from the protocol need to be specified. A data model is required which enables the WSD to query the database while including all the relevant information such as geo-location, power characteristics, sensing capabilities, etc. which may be country and spectrum and regulatory dependent. Partially following IETF proposal [4], but adapted to the CREW-TV project, the implemented geo-location database is able to interpret the data model and respond to the queries using the same data model that is understood by all WSDs.

The Application Protocol utilizes the following protocol stack for communication between the geo-location database and a master WSD:

Application Layer (HTTPS); Presentation Layer (XML); Session Layer (Undefined); Transport Layer (TCP); Network Layer (IP); Data Link (Undefined); Physical Layer (Undefined).

Several programming languages, from MySQL, PHP and JavaScript, were used to develop this implementation of CREW-TV PAWS. MySQL is the technology used to implement all the requirements for the database: to store geo-location data, information about all Master WSDs (Registration Process), and the Slave WSDs (serial number only). In the context of CREW-TV PAWS development, the main objective of PHP is to access a MySQL database, where the TVWS geo-located data is stored. JavaScript language is used to control the user web interface and the Google maps API.

Three services are defined on the interface between the geo-location database and WSDs: Service 1 - Registration; Service 2 - Channel List Request, and Service 3 - ID Verification.

The services are listed in order, representing the steps that a WSD must take to obtain service from the geo-location database. Several timers are also implemented and used by the protocol, during operation:

- CLRP (1440 minutes): Channel List Refresh Period;
- CRT (5 seconds): Channel list Request Timer;
- VRT (5 seconds): ID Verification Request Timer;
- RVP (90 days): Registration Valid Period.

To give a glimpse of the protocol implementation to the interested user, with the possibility to test the protocol implementation, we create a web-based Graphical User Interface (GUI). All messages presented are XML code that contains all relevant parameters defined from the protocol and data model requirements.

References:

[1] <http://www.ietf.org>

[2] <http://datatracker.ietf.org/wg/paws/>

[3] <https://mentor.ieee.org/>

[4] <http://datatracker.ietf.org/doc/draft-ietf-paws-problem-stmt-usecases-rqmts/>