

Motorola, Inc.

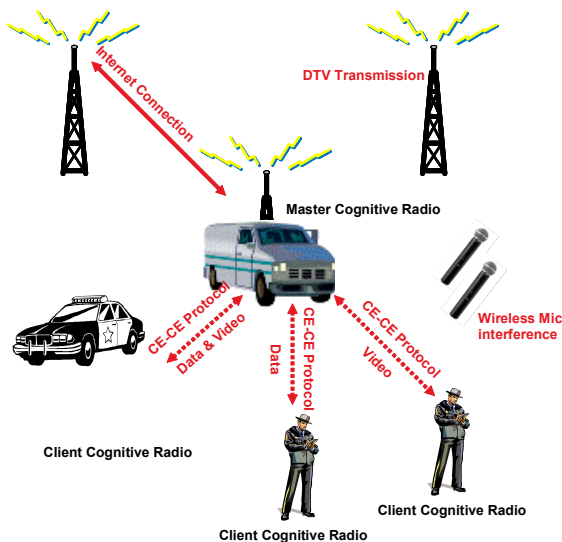
TV White Space Cognitive Radio Demonstration

Background

In February 2009, sections of the VHF and UHF Bands, currently being used by analogue TV, will be vacated and be made available for digital television (DTV) transmissions. This change of assignment frees up some channels – so called TV White Space (TVWS) – and opens up new opportunities for users and communication companies alike for enterprise, public safety, and other applications.

Example Scenario

At an incident scene, emergency services need to rapidly deploy a communication system. Priorities of the system are manifold but flexible data options and robust system performance are clearly of huge importance. The following diagram shows an example for discussion.



The diagram shows an incident where data and video services are required by personnel and vehicles. A Master Cognitive radio provides the TVWS communication links for users along with all channel sensing and resource management and internet links. Within the environment exists a number of incumbent transmitters (DTV stations, licensed wireless mics). The Master Cognitive radio ensures that communication is setup on a channel not used by licensed incumbents, using a power level that ensures no incumbent users suffer interference.

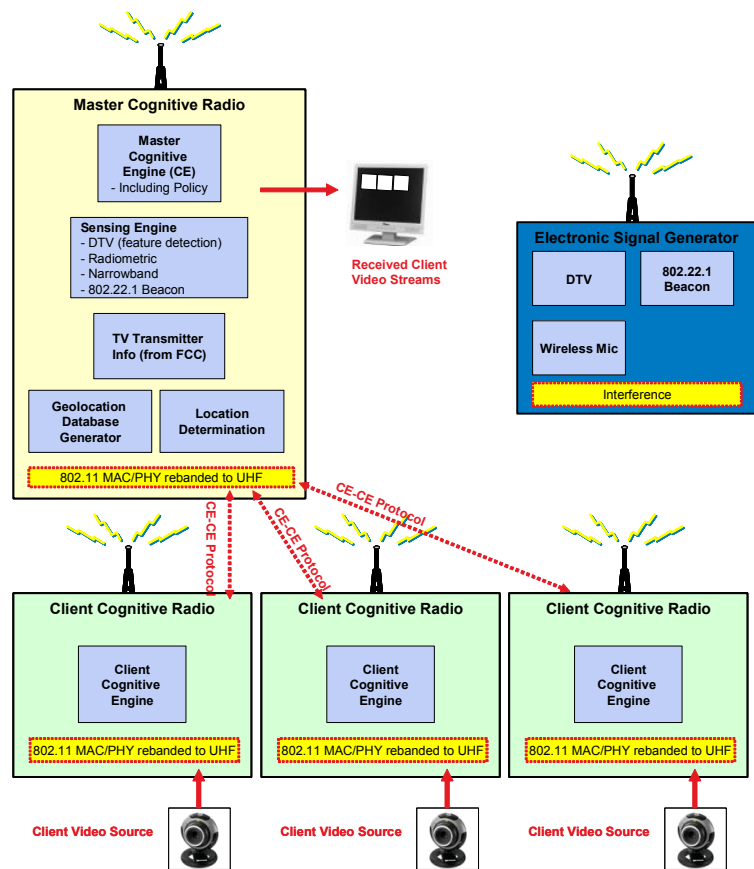
The Demonstration System

The diagram below shows the Motorola Cognitive Radio demonstration system, consisting of a Master Cognitive radio and three Client Cognitive radios. The demonstration shows individual video streams from the Client Cognitive radios being transmitted to the Master Cognitive radio and displayed on a local terminal. Each of the radios uses a non-proprietary 802.11 MAC/PHY that has been rebanded to UHF.

Initially, the Master Cognitive radio utilized the TV Transmitter Information and Geolocation databases to select channels upon which to operate, to avoid interfering with incumbent users. This initialization stage classifies the available channels in terms of suitability and available transmit power, The Master Cognitive radio then senses the UHF environment to rank the available channels in terms of channel quality and interference. For demonstration purposes, incumbent sources are also scanned for. Once classified and an operational channel is selected, the Master Cognitive radio uses the CE-CE Protocol link (a robust communications channel) to distribute active and backup channel information and rendezvous times to its Client Cognitive radios. Once all Radios are on channel and synchronized, video streaming begins.

The CE-CE Protocol has been designed to allow the Cognitive radios the opportunity to continuously sense the active and backup channels to ensure the system can react to interference or incumbents when they occur.

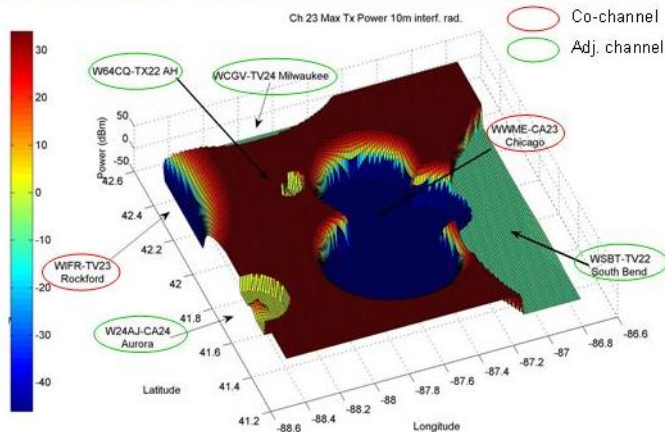
To demonstrate the ability of the system to react to incumbents and interference, the Electronic Signal Generator (ESG) has been configured to provide different types of signal. The ESG can be tuned to the Cognitive system's active channel and the streaming video observed as the interference is introduced. The Master Cognitive radio will sense and classify the interference and via the robust CE-CE protocol will instruct the Client Cognitive radio to change channel to one of the backup channels. At the appropriate time, the radios will rendezvous and the streaming will continue.



Geolocation Database

The Cognitive Radio Demonstration system makes use of databases which provide the maximum allowable transmit power that may be used on any one channel to avoid local adjacent-channel interference and distant co-channel interference. This functionality is based upon FCC-proposed operating rules for a given region along with proprietary analysis. The Master Cognitive radio interfaces directly with the results of this code to ensure that candidate channels are chosen quickly and accurately when the cognitive system is setup.

Max Allowed WSD EIRP vs. Lat-Long Coordinates



The figure (left) shows a Matlab generated graphic describing the maximum EIRP versus location coordinate for operation on channel 23 in the Chicago area. The color code indicates the allowed EIRP to satisfy various co- and adjacent channel requirements.