Antenna Functionalities in a Cognitive Radio Environment

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It is well known that a cognitive radio is based on software defined radio with cognition ability. For a cognitive radio device to function properly, it should follow a closed loop cycle. This cycle is based on (1) observing the channel activity, (2) deciding which part of the spectrum is suitable for communication, (3) acting appropriately to achieve the required mode of communication, and (4) learning from previous channel activity. A cognitive radio device operates in either "interweave" or "underlay" mode. In both types of operation, the unoccupied parts of the spectrum also called "white spaces" are always inspected. The primary and secondary users, once identified, are allocated dynamically to the different parts of the spectrum.

The "observe" part is identified by the ability of a cognitive radio device to sense the available RF spectrum. This process allows the detection and identification of the available RF signals used by the primary and secondary users. An example of an antenna system designed for both interweave/underlay consists of a wideband sensing antenna. Therefore, one of the main challenges of the "observe" part in both interweave and underlay is the high sampling rate required to sample and analyze the RF signals acquired by the wideband antennas.

The "decide" section in the cognitive cycle is based on analyzing the data obtained from the "observe" part. The objective here is to identify the primary users that can't tolerate any interference level from active secondary users as well as identify the different types of signals that are observed at a particular frequency band in the "observe" part.

At the "act" stage, the cognitive radio device changes its mode of operation based on the decision taken from the analysis of the sensed RF signals. Therefore, the main job is to make sure that the cognitive radio device is able to change its mode of operation based on the specifications drawn from the "decide" part. For the interweave case, two sets of antennas are required. One antenna is dedicated to achieve sensing in the "observe" part. The second antenna is a frequency reconfigurable antenna required to achieve the "act" function. For the underlay case, the same wideband sensing antenna should be able to create notch frequencies that are reconfigurable in order to block some active primary users.

The most important feature in a cognitive radio environment is the ability to learn from previous channel activity in order to predict future outcomes. The operation of the cognitive radio environment is based on the implementation of learning algorithms. It is this unique feature that differentiates a cognitive radio platform from software defined radio.