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Cognitive Radio in Aeronautic: Comparison of Some Spectrum Sensing Technics

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Abstract : The aeronautical field is experiencing issues with RF spectrum congestion due to the constant increase in the number of flights, aircrafts and telecom systems on board. In addition, these systems are bulky in size, weight and energy consumption. The cognitive radio helps particularly solving the spectrum congestion issue by its capacity to detect idle frequency channels then, allowing an opportunistic exploitation of the RF spectrum. The present work aims to propose a new use case for aeronautical spectrum sharing and to study the performances of three different detection techniques: energy detector, matched filter and cyclostationary detector within the aeronautical use case. The spectrum in the proposed cognitive radio is allocated dynamically where each cognitive radio follows a cognitive cycle. The spectrum sensing is a crucial step. The goal of the sensing is gathering data about the surrounding environment. Cognitive radio can use different sensors: antennas, cameras, accelerometer, thermometer, etc. In IEEE 802.22 standard, for example, a primary user (PU) has always the priority to communicate. When a frequency channel witch used by the primary user is idle, the secondary user (SU) is allowed to transmit in this channel. The Distance Measuring Equipment (DME) is composed of a UHF transmitter/receiver (interrogator) in the aircraft and a UHF receiver/transmitter on the ground. While the future cognitive radio will be used jointly to alleviate the spectrum congestion issue in the aeronautical field. LDACS, for example, is a good candidate; it provides two isolated data-links: ground-to-air and air-to-ground data-links. The first contribution of the present work is a strategy allowing sharing the L-band. The adopted spectrum sharing strategy is as follow: the DME will play the role of PU which is the licensed user and the LDACS1 systems will be the SUs. The SUs could use the L-band channels opportunely as long as they do not causing harmful interference signals which affect the QoS of the DME system. Although the spectrum sensing is a key step, it helps detecting holes by determining whether the primary signal is present or not in a given frequency channel. A missing detection on primary user presence creates interference between PU and SU and will affect seriously the QoS of the legacy radio. In this study, first brief definitions, concepts and the state of the art of cognitive radio will be presented. Then, a study of three communication channel detection algorithms in a cognitive radio context is carried out. The study is made from the point of view of functions, material requirements and signal detection capability in the aeronautical field. Then, we presented a modeling of the detection problem by three different methods (energy, adapted filter, and cyclostationary) as well as an algorithmic description of these detectors is done. Then, we study and compare the performance of the algorithms. Simulations were carried out using MATLAB software. We analyzed the results based on ROCs curves for SNR between -10dB and 20dB. The three detectors have been tested with a synthetics and real world signals.

Keywords : aeronautic, communication, navigation, surveillance systems, cognitive radio, spectrum sensing, software defined radio
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