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Performance Evaluation of Spectrum Sensing in Cognitive Radio Network

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***Abstract*-cognitive radio is a technology which uses primary user and secondary users. Primary users are the licensed spectrum and secondary users are the unlicensed spectrum. In cognitive radio Spectrum sensing is a challenging task. Energy detection is one of the spectrum sensing technique for cognitive radio. In this paper we analyze the performance of energy detection technique to detect primary user (PU). Simulation results show that the probability of detection increases when signal to noise ratio increases. It is also observed that the detection probability decreases when the bandwidth factor increases.**

Index Terms— Cognitive Radio, Spectrum Sensing, Energy Detection

I.INTRODUCTION

Cognitive Radio (CR) is a technology which have primary users and secondary users. Primary users are the licensed spectrum and the secondary users are unlicensed spectrum. It enhances the utilization of the radio spectrum [1]. The spectrum scarcity problem is solved by using cognitive radio technology. The secondary users occupy the licensed spectrum if the primary user is in available condition. So the spectrum scarcity problem is resolved in this technique. Always primary users have the first priority to use the frequency of the spectrum and the secondary user is the opportunistically access the spectrum. So the relationship between the primary and the secondary users are master-slave condition [2].

In a broadcasting service the frequencies are not used locally which is called “white spaces or spectrum holes”. The problem was solved by using the technique dynamic spectrum access. The white spaces are identified by the wireless nodes. This nodes are uses the spectrum and sensing the white spaces. So it will be occupied by the secondary users. So the primary user is not affected by the secondary users [3].

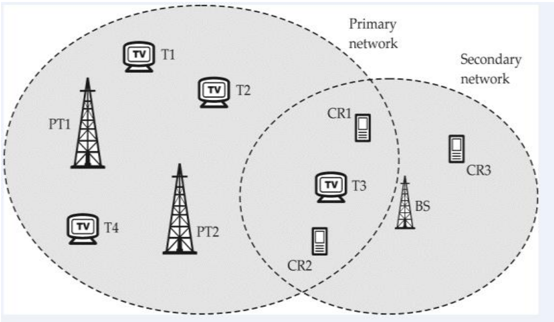

Fig 1: Cognitive Radio Network

There are two major challenges of multi channel MAC of collision avoidance/resolution and channel access. Collision avoidance/resolution is received from conventional MAC [3]. In recent year the new challenging issue of wireless communication is channel access negotiation. A new location is placed transmitter and receiver to negotiate the channel for implementation, before transmission.

CR MAC protocol has two approaches. They are (i) standardization efforts leading to the formation of the IEEE 802.22 working group and (ii) application scenario specific protocols. In the formation based approach is concentrate mainly on infrastructure based networks, in which the base station manages the spectrum allocation and spectrum sharing to the CR users. The next approach (application or scenario specific protocols) is optimized for a particular environment. This approach uses to distributed CR MAC protocols, that operates without central station. Fig 1 shows the cognitive radio network. It explains clearly about the primary and secondary users.

II. SYSTEM MODEL

In a licensed spectrum band with L sub-channels which are licensed to a primary wireless network consisting of N PUs, where the sub-channels are implemented by the same frequency bands in different time-slots. The PUs have more important than the secondary users in priority level. When a primary user wants to initiate a transmission, it follows the *p*-persistent Carrier Sense Multiple Access (CSMA) protocol to access the licensed sub-channels. To efficiently utilize the spare spectrum, M SUs with the low-priority queue idle spectrum opportunities in the licensed spectrum band. The SUs also follow the *p*-persistent CSMA protocol to avoid the confliction. The PUs and the SUs form the primary wireless network and the secondary wireless network, respectively.

However, in multichannel non-time slotted CRNs, the Pus randomly access and leave the licensed channel. The wireless half-duplex spectrum sensing schemes cannot solve the

The traditional wireless half-duplex spectrum sensing (for example, the wireless half-duplex-based energy detection spectrum sensing scheme), the SU can sense the idle sub-channel using the short sensing period. Then, the SU occupies the sub-channel. However, because of the asynchronization between the PUs and the SUs, the PU's contention for reactivation in the licensed sub-channel may conflict with the SU's transmission. Therefore, with the wireless half-duplex spectrum sensing schemes, it is impossible to solve the reactivation-failure problem in multichannel non time- slotted CRNs. We need to develop the efficient spectrum sensing scheme to solve the reactivation-failure problem in multichannel non-time-slotted CRNs.

In the following we first develop the wireless full-duplex spectrum sensing (FD-SS) scheme for multichannel non-time- slotted CRNs. Using the wireless FD-SS scheme, the SU can sense the PU's reactivation during the same time when the SU is transmitting its signal. Then, based on the developed wireless FD-SS scheme, we further develop the wireless FDC-MAC protocol to solve the reactivation-failure problem in multichannel non-time-slotted CRNs.

III. WIRELESS FULL-DUPLEX SPECTRUM SENSING

Several signal detection techniques, such as the energy detection, feature detection, and matched filter, can be used for the SUs to sense the presence of the PUs. We mainly focus on the energy detection approach because the energy detection approach is efficient and simple to be implemented in hardware. More importantly, the energy detection approach does not require the knowledge of signal features of the PUs, which typically may not be known to the SUs. Let H_{01} and H_{10} be the hypotheses that the PU changes from inactive state to active state and from active state to inactive state, respectively, during one sensing period of SUs. To detect the random access and departure of the PUs, the SUs need to sense the licensed channel not only in the sensing period but also in the transmission period. To enable the SUs' sensing during the transmission period, the SUs need to use the wireless full-duplex mode with transmitting and sensing simultaneously. To sense the licensed sub-channels in the SUs' transmission period, we divide each time-slotted frame of SUs into *V* periods. Since the SUs use the wireless full-duplex mode, they can transmit data and sense the sub-channels simultaneously during the entire time-slotted frame.

$$p_f(\epsilon, U, d, \kappa) = \frac{1}{\sqrt{2\pi}} \int_{\alpha(\epsilon)}^{\infty} exp\left(-\frac{z^2}{2}\right) dz$$
$$= Q\left(\frac{\frac{\epsilon}{\sigma_u^2} - \frac{d}{U}\kappa\gamma_{ps} - 1}{\sqrt{\frac{d}{U^2}\left(\kappa\gamma_{ps}+1\right)^2 + \frac{U-d}{U^2}}}\right)$$

U is the number of samples, γ_{ps} is the received SNR, σ_U^2 is the variance of the noise. Where ϵ is the energy detection threshold and Q(x) is the complementary distribution function of the standard Gaussian, which can be written as follows:

$$p_d(\epsilon, U, d, \kappa) = Q\left(\frac{\frac{\epsilon}{\sigma_u^2} - \frac{U-a}{U}\kappa\gamma_{ps} - 1}{\sqrt{\frac{U-a}{U^2}\left(\kappa\gamma_{ps}+1\right)^2 + \frac{a}{U^2}}}\right)$$

IV. PERFORMANCE ANALYSIS

In this section, we evaluate the wireless FD-SS based FDCMAC protocol for multichannel non-time-slotted CRNs with numerical results. First, we compare the probabilities of false alarm and detecting a PU corresponding to non-time-slotted

CRNs with the probabilities of false alarm and detecting a PU corresponding to time-slotted CRNs. Second, we show the impact of residual self-interference on the wireless FD-SS scheme. Third, we evaluate the throughput of PUs and SUs with the wireless FDC-MAC protocol in multichannel non-timeslotted CRNs. The main parameters for our proposed wireless FDC-MAC protocol. The probability of false alarm and the probability of detecting a PU are briefly written as p_f and p_d, respectively. To reveal the impact of asynchronization on the probability of false alarm and the probability of detecting a PU, we compare

the probabilities of false alarm and detecting a PU corresponding to non-time-slotted CRNs with the probabilities of false alarm and detecting a PU corresponding to time-slotted CRNs. compares the probability of false alarm corresponding to non-time-slotted CRNs with the probability of false alarm corresponding to time-slotted CRNs. For the nontime-slotted CRNs, we consider two scenarios: 1). d = 500, M = 1500, and κ = 1; 2). d = 1000, M = 1500, and κ = 1. As shown in Fig. 2, the asynchronization between the PUs and the SUs results that the probability of false alarm corresponding to non-time-slotted CRNs is higher than the probability of false alarm corresponding to time-slotted CRNs. The probability of false alarm increases as *d* increases corresponding to non-timeslotted CRNs. As illustrated in Fig. 2, the asynchronization between the PUs and the SUs results that the probability of detection corresponding to non-time-slotted CRNs is lower than the probability ofdetection corresponding to time-slotted CRNs. The probability of detection decreases as *a* increases in non-time-slotted CRNs.

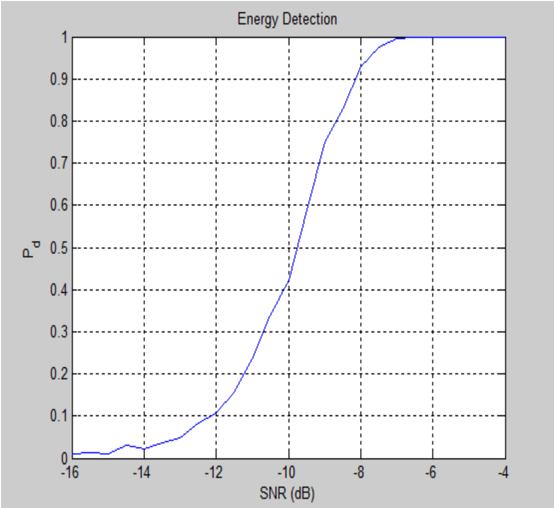

Fig 2: SNR Vs Probability of detection

This figure explains the SNR gets increased and also probability of detection increased simulataneously and one time it will maintain constantly.

V. CONCLUSION

In this paper we discussed about the spectrum sensing in cognitive radio. It senses the spectrum of primary users and to occupy the primary user frequency which overcomes the secondary users. In this paper proposed the new probability of false alarm and probability of detection value in cognitive radio environment.

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