A Survey on Outage Analysis in Cognitive Two-Way Relay Network with Opportunistic Relay Selection under Primary user's Interference

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***Abstract*— During the topical era, the majority of the researches are paying attention in the field of Cognitive Two way relay networks (CRNs) by means of opportunistic relay section below main user's interface. At this time contain listening carefully in the field of interference with some efficiency which occur connecting minor users (SUs) to most important users (PUs) whereas relations beginning major transmitters (PTs) to less important users (SUs) encompass not been in use under thought. In this paper have discussed both the interferences which are occurs connecting SUs to PRs and PTs to SUs with the opportunistic communicate part under primary user's interference. In the minor system the closed form of the outage probability is resulting more various fading channels and these experiments have been verified from beginning to end various simulations. An asymptotic expression and diversity order are also derived. In this survey many things found like outcome of the positions of PT, PR and secondary relays on the outage presentation of the secondary system have been considered for the proposed work. End of the work result placement which is very much necessary to achieve a better outage performance especially when the no of relays are large. In this paper the survey made on concept of cognitive two-way relying with opportunistic relay section have been almost exact so that able to focus taking place addressing the network placement development.**

Keywords*— Cognitive two-way relay networks; physicallayer network coding; opportunistic relay selection; system outage performance

I INTRODUCTION

The wireless communication have witnessed a revolutionary rise in applications and consumers over the past few years. The demand for inexpensive but high speed data services, such as wireless Internet access with rich video content has driven the wireless communications towards high quality and high speed wireless communication services. Due to the 'any time in any where' flexibility of the wireless communications, the consumer demands are growing exponentially resulting in an increase in the demand for the radio spectrum. The definition of cognitive radio considers a high level of awareness to employ intelligence in the choice of the radio spectrum band, air interface, or protocol to higher-level tasks of planning, learning, and evolving new upper layer protocols Cognitive radio network many unlicensed users who are considered as a secondary users are allowed to use the licensed band so long so that they can protect the data transmission of the licensed (primary user) with the use of spectrum underlay and interweave approaches. Recently some underlay spectrum sharing protocols are under consideration the underlay paradigm allows Cognitive (secondary) users to utilize the licensed spectrum if the interference caused to primary users is below a given interference threshold. Owing to the constraint on the transmit power, the performance of cognitive underlay protocols is severely degraded in fading environments. Here some methods are proposed to improve the performance of secondary network is to use cooperative Communication with multiple relays. As we understand that the cooperative communication is the approach to improve the channel capacity and achieve higher diversity gains in fading environments. Besides, owning to the diversity techniques, the cooperative cognitive relay can mitigate the signal fading which arises from multipath propagation and improve the outage performance of wireless networks. Due to bidirectional nature of communication networks, a promising relay technique, two-way relaying, has attracted much attention. Two-way relaying has higher spectral efficiency than the traditional one-way relaying. It is thus natural to incorporate two-way relaying into cognitive networks to further enhance the spectrum utilization. Authors introduced analog network coding into the cognitive relay network where two secondary user (SU) transceivers exchange their information with the assistance of a relay under IT constraint. The physical-layer network coding (PNC) based cognitive two-way relay network (CTRN) is discussed in [9] where two secondary transceiver nodes who are located on two different primary use (PU) coverage areas. Exchange their information with the assistance of a relay in underlay spectrum sharing environment.

As we all know, the outage probability is an important performance indicator for cognitive relay systems. Though the two-way relaying scheme was proposed for three time slots, it had verified the two-way relaying scheme has better outage performance than one way relaying. In this paper, we build upon the work of and analyze the outage performance for the PNC based CTRN with IT constraint to PUs. Meanwhile, in order to give an explicit relation between the practical channel fading and the outage probability of cognitive relay network, the outage performance under Nakagami-m fading channels is analysed, since this channel model has been extensively studied in various wireless communication systems and can capture the physical channel phenomena more accurately than Rayleigh and Rician models. Eventually, we derive the tight upper bound on the outage probability of the PNC based CTRN and then investigate the impact of various key system parameters, such as interference temperature and channel fading severity on the outage probability of the system.

II COGNITIVE RELAY NETWORKS

The advantages offered from the cooperative relays to enhance the traditional cognitive radio's performance have led to the research of how cooperative relays can be brought into the cognitive radio picture.. Several distributed transmit power allocation schemes for cooperative relay assisted cognitive radio employing the underlay approach relays re-adjust their power so that they can meet all interference and power constraints to allow a low power transmission. Hence, there is no interference to the primary users. The performance of a cognitive radio network has been analysed in terms of information theoretic metrics (i.e, channel capacity and achievable rates). Three different cognitive radio approaches for single/multiple cognitive use(s) have been studied as follows.

A. Intereference mitigating approach:

In this approach, two users can simultaneously transmit over the same time/frequency slot. The cognitive user will listen to the channel and only transmit if the primary user is not transmitting. However, if a primary is sensed, the cognitive radio can decide on simultaneous transmission. These information help to mitigate the interference collaborative approach explains that a cognitive user can act as a relay to collaborate with the primary user when it does not transmit. In this way, a cognitive relay actually improves up the primary transmission.

B. Interference avoiding approach:

According to the current FCC proposals on opportunistic channel usage, the cognitive radio listens to the wireless channel and determines the unused spectrum parts in either time or frequency slots. Then it adapts its signals accordingly to access the spectrum slot avoiding interference with primary users. A number of interference avoiding method are in ad-hoc cognitive radio environment using multi-hop relays. The interference based methods are as follows avoidance by using media access control (MAC) protocol.

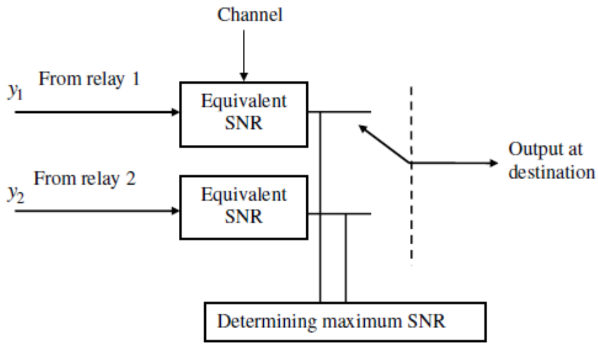

Fig. 1: Cognitive Relay Networks

B. Interference tolerant approach (i.e., underlay approach):

Interference reduction method (limiting the transmission power of the transmitter of the cognitive radio). Interference cancellation by using signal processing. The cooperative transmission involves a secondary user acting as a relay for a secondary source and even for a primary source. The later will allow the primary user to reduce its transmission power and so increase the transmission opportunity for other secondary users.

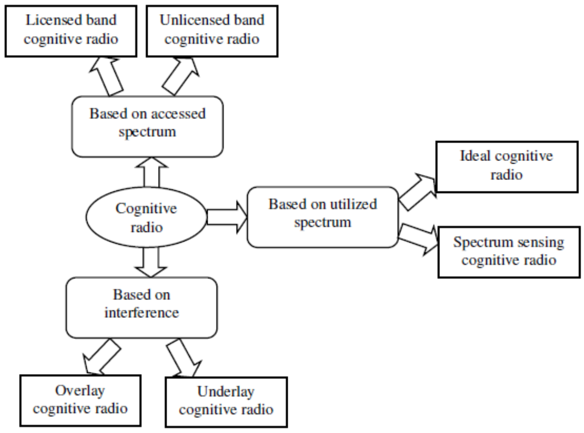

Fig. 2: Classifications of Cognitive Radio

The chart in Figure 2 presents a summary of the classifications of cognitive radio. Depending on the utilization of the spectrum band, the cognitive radio.

III PERFORMANCE METRICS

The performance metrics is to evaluate the outage probability of the proposed cognitive relay network. Average SNR: One of the most common performance measure metrics used in a wireless communication system is SNR. However, the average SNR is a more appropriate metric for a wireless communication system affected by the fading phenomenon. Here 'average' indicates to the statistical averaging over pdf of the fading channel. Mathematically, if represents the instantaneous SNR, then. Is the average SNR. In p_γ $\gamma(\gamma)$ is the pdf of γ

$$\bar{\gamma} \triangleq \int_0^\infty \gamma p_\gamma(\gamma) d_\gamma$$

Average SNR is also *useful* for a cooperative relay network to combat with fading/shadowing effects.

Outage probability: Outage probability is another widely used performance measurement metric for a wireless diversity system affected by fading. It is defined as the probability of the instantaneous error probability exceeding a particular value (or the probability of the output SNR,) at the destination. The Outage probability is denoted by P_{out} and mathematically

$$p_{out}\int_{0}^{\infty} p_{\gamma}(\gamma)d\gamma$$

The outage probability can be defined as the cdf. The slow independent and identically distributed Rayleigh fading channel considered in this work, outage probability can be expressed as the probability that the mutual information of the channel falls below a particular rate at a given SNR. Mathematically, $Pout = \Pr[\gamma < \gamma_{th}]$.

IV RELATED WORK

Steenkiste et al [1]. anticipated that cognitive radio technology will soon emerge from early stage laboratory trials and vertical applications to become a general-purpose programmable radio that will serve as a universal platform for wireless system development, much like microprocessors have served a similar role for computation.

Zhang et al [2]. Analysed in this paper, both the interference from SUs to PRs and from PTs to SUs are considered in the analysis of cognitive two-way relay networks with opportunistic relay selection. The exact closed-form expression for the outage probability of the secondary system is derived over Rayleigh fading channels, which is verified through various Monte-Carlo simulations. Meanwhile, an asymptotic expression and diversity order are also derived to reveal additional insights into the effect of the mutual interference between the primary and secondary systems on the diversity. Above all, based on the analysis, the effects of the positions of PT, PR and secondary relays on the outage performance of the secondary system are studied. Our results reveal that the network placement planning is desperately necessary in order to achieve a better outage performance.

Liu et al [3]. In this paper, the outage probability is investigated for the physical-layer network coding (PNC) based cognitive two-way relay network over Nakagami-m fading channel. By applying the interference temperature (IT) constraints at the transceiver nodes and relay nodes in secondary system, we analyze the outage performance in underlay spectrum sharing with the best relay selection criterion. The cumulative distribution function (CDF) of the signal to noise ratio (SNR) for each link is derived to obtain the tight upper bound on the outage probability of the secondary relay system. Simulations results demonstrate the validity and accuracy of the theoretical analysis.

Goldsmith [4]. Developed the fundamental capacity limits and associated transmission techniques for different cognitive radio network paradigms. These limits are based on the premise that the cognitive radios of secondary users are intelligent wireless communication devices that exploit side information about their environment to improve spectrum utilization. This side information typically comprises knowledge about the activity, channels, encoding strategies and/or transmitted data sequences of the primary users with which the secondary users share the spectrum. Based on the nature of the available side information as well as a priori rules about spectrum usage, cognitive radio systems seek to underlay, overlay or interweave the secondary users, signals with the transmissions of primary users. This chapter develops the fundamental capacity limits for all three cognitive radio paradigms. These capacity limits provide guidelines for the spectral efficiency possible in cognitive radio networks, as well as practical design ideas to optimize performance of such networks.

Wyglinski et al [5]. Described the benefits, from a theoretical perspective, of cooperative communications were introduced. In this chapter we expand upon cooperative communications by allowing a subset of the nodes to be cognitive radios with their own data to transmit (and not merely relay), thereby forming cognitive radio networks.

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Raval et al [7]. Presented the overview of cognitive radio, importance of relaying network, and relay selection algorithm and resource allocation in cognitive radio.

Steenkiste et al [8]. Have presented a NSF sponsored workshop (held in Arlington, VA on March 9-10, 2009) was to bring together a group of technology and policy researchers who have been involved with early cognitive radio projects, and to explore how we can make the transition from cognitive radios to cognitive radio networks.

Surobhi [9]. Considered the incorporation of cooperative relays into a cognitive radio network. Cognitive radio is a potential solution to the growing scarcity of radio spectrum and the increased demand for wireless services. Cooperative relay networks can help cognitive radios to improve their utilization by reducing their transmit power. This allows a reduction in their interference footprint and increases their probability of accessing licensed spectrum, improving throughput, and/or coverage. A cognitive relay network model has been analysed to derive the closed-form outage probability expressions for the repetation-based and selection-based protocols. Both decode-and-forward and amplify-and-forward relaying schemes have been employed for these protocols.

Wu et al [10]. Proposed an opportunistic relay selection scheme for a cooperative and cognitive radio system. In the secondary network, two secondary users (SU) exchange information with each other via an assist relay and share the spectrum with the primary network. By using optimal power allocation among the SUs and relay, we analytically derive the outage probabilities of the secondary network under the constraints of limiting an outage probability of primary network to satisfy a required target. A tight closed-form expression is obtained to evaluate the secondary network performance of opportunistic relay selection. Numerical and simulation results demonstrate the diversity gain over opportunistic relay selection and verify the analysis.

Alizadeh et al [11]. Proposed a cognitive two-way relay network which consists of two transceivers (primary users) and multiple cognitive terminals. The two transceivers transmit their data toward the cognitive terminals which sense the spectrum constantly. If the primary users are in operation, the cognitive terminals act as relay nodes by multiplying the received signal by a beam forming coefficients and then broadcasting the so obtained signal to the transceivers. When the primary users are not in operation, the cognitive terminals communicate with a base station (BS) to increase the overall throughputs.

Wang et al [12]. Proposed a cognitive transmission scheme for Amplify-and-Forward (AF) two-way relay networks (TWRNs) and investigate its joint sensing and transmission performance. Specifically, we derive the overall false alarm probability, the overall detection probability, and the outage probability of the cognitive TWRN over Rayleigh fading channels. Furthermore, based on these probabilities, the spectrum hole utilization efficiency of the cognitive TWRN is defined and evaluated. It is shown that smaller individual or overall false alarm probability can result in less outage probability and thus larger spectrum hole utilization efficiency for cognitive TWRN, and also produce more interference to the primary users.

V ISSUES AND CHALLENGES

A wireless network consists of a collection of wireless devices communicating over a common wireless channel. The simplest wireless network consists of a single-user (point-to-point) channel. In general, a wireless network contains multiple source nodes, each communicating its information to a set of destination nodes. A wireless network can have a supporting infrastructure (e.g. as in cellular networks), or an ad hoc structure, where nodes self-configure into typical topologies of multiuser channels (in isolation or within one cell of a cellular system) are multiple access (many transmitters to one receiver) and broadcast (one transmitter to many receivers) channels. These channels correspond, respectively, to the uplink and downlink of a satellite system or one base station in a cellular system. In these networks, communication occurs between a group of nodes transmitting to or receiving from a single node. In an ad hoc wireless network, each node can serve as a source, destination and/or relay forwarding data for other users. In cognitive radio applications, primary and secondary users accessing the same spectrum form a wireless network. Primary and secondary users have different transmit/receive constraints due to interference limitations at the primary receivers, as well as possibly different transmit/ receive capabilities. In cognitive radio networks the primary users can be cellular or ad hoc, whereas the secondary users are generally ad hoc and fall into the paradigms of underlay, interweave or overlay. Hence, these two types of cognitive radio network users form a two-tier wireless network. Performance limits of wireless networks are thus of direct relevance to the performance limits of cognitive radio networks. In particular, the fundamental capacity limits of ad hoc networks not only dictate how much information can be transmitted by secondary users under a given set of network and interface conditions, but also limitations on the information exchange possible between sensing nodes to collaboratively assess spectral occupancy. In the following section we describe the broad range of performance metrics relevant to wireless networks, including their capacity. We then formally define mutual information and capacity for single-user channels as well as for general wireless networks. In the underlay spectrum sharing protocol, SUs are allowed to use the licensed spectrum of PUs as long as the interference from SUs to PUs does not exceed the interference power constraints at the PRs. As a result, more works on CRNs focus on the study of primary user's interference power constraints. However, the potential interference from the PTs to secondary receiver is usually not taken into consideration or has been simply translated into the noise term of the SU. In practice, this assumption is unreasonable because the interference is distinguished from the noise by its statistical properties. The main two challenges to the success of cognitive radio include the primary user detection and the transmission opportunity exploitation. Detection of a primary user actually leads to the detection of a spectrum hole. A spectrum hole is an unoccupied spectrum band which is licensed to the primary user. In the literature, spectrum hole detection is known as the 'spectrum sensing'. The cognitive users can exploit the opportunity of transmission to improve their performance through either overlay approach or underlay approach. Regardless of the approach employed by the cognitive radio, the inherited fading phenomena of the wireless channels limits the service reliability and coverage of the wireless communication services.

VI CONCLUSION

In this survey the operation of a cooperative relay network has been investigated the performance of the proposed cognitive relay network has been analyzed specifically in terms of the outage probability based on several sensible assumption. In this paper, We concentrated many related work on top of performance for cognitive two-way relay networks under primary user's interference. We describe issues and challenges of Cognitive Two-Way Relay Network towards Relay Selection under Primary User's Interference By taking consideration of the links from primary transmitter to secondary receivers,. The next work is to propose a novel structure for outage probability and analyze the effect of the transmit power of PT thoroughly. The precise outage probability is derived to give an efficient method to investigate the impact of the related system parameters. In the meantime, an asymptotic look is also obtained to study the effect of the mutual interference between primary and secondary systems on the diversity order. Furthermore, We also analyse the secondary system outage performance when the network deployment is changing. In sensible operation for cognitive two-way relaying with opportunistic relay selection, appropriate network situation developments have to be charily careful.

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