

Single relay hybrid approach improved security and reliability trade off in cognitive radio network

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Abstract

We consider a cognitive radio network consisting of a secondary transmitter, a secondary destination and multiple secondary relays in the presence of a snoop .where the secondary transmitter transmits to the secondary destination with the assistance of secondary relays, while the snoop attempts to intercept the secondary transmission. We rely on careful relay selection approach for protecting the secondary transmitter-secondary destination transmission against the snoop with the aid of single-relay. Decode amplify and forward relaying scheme is applied for single relay selection approach .Hybrid relaying scheme implies a trade-off between the security and reliability of the secondary transmission in the presence of snoop attacks.

Index Terms—Security-reliability trade-off, relay selection, intercept probability, outage probability, Amplify Forward, Decode Forward ,cognitive radio

1:- Introduction

Today's wireless networks are identified by a fixed spectrum assignment policy. However, a large portion of the assigned spectrum is unused. Cognitive radio technology is the key technology that enables a next generation network to use spectrum in a dynamic manner [7]. The Cognitive Radio is a radio that can change its transmitter parameters based on interaction with the environment in which it operates.

Dynamic spectrum access techniques allow the cognitive radio to operate in the best feasible channel. More specifically, the cognitive radio technology will enable the

users to determine which portions of the spectrum is available and detect the presence of licensed users when a user operates in a licensed band , select the best available channel , coordinate access to this channel with other users, and vacate the channel when a licensed user is detected .

When cooperative relay based networks are used; two paths become really important first the sensing paths from the source to the cognitive users (relays), and second the relaying paths from the relays to the receiver [2]. There are two types of protocols generally used in these networks either Amplify Forward (AF) protocol or Decode Forward (DF) protocol. In AF protocol measurements are sent to fusion center and

In DF protocol decisions are sent to fusion center. The advantage of DF protocol is that it needs less bandwidth on the other hand AF protocol helps in reducing complexity at the local radios [11]. The fixed-gain relay based on amplifies and forwards the received signal with a constant gain. Fixed-gain relay also reduces the complexity of relay. The secondary users with higher detection probabilities constantly act as relays to help those with lower detection probabilities in a distributed network with i.i.d. Rayleigh fading channels is considered. The next generation wireless systems are supported to handle high data rate as well as large coverage area. It should consume less power and utilize bandwidth efficiently [16]. We analyze the performance decode amplify and forward relaying scheme that improve the security by using single relay hybrid protocol. We also see that multiple fading on relaying channels. For this paper the network performance is analyzed for a number of source nodes for m number of relays. The simulation result is measured by considering six nodes in half duplex mode. Our numerical result shows the SRT performance of single relay hybrid selection approach.

2:- Methodology

In this only the best secondary relays is chosen. By using secondary transmission we analyze both the intercept probability and outage probability. We also evaluate the performance of direct transmission based method for the purpose of comparison with the proposed relay selection schemes. The

intercept probability requirement is relaxed; the outage performance of the direct transmission, selection schemes improves.

Let H_0 and H_1 represent the event that the licensed spectrum is unoccupied and occupied by the primary base station [1]. Moreover, let H denote the status of the licensed spectrum detected by spectrum sensing. Specifically,

$H = H_0$ represents the case that the licensed spectrum is deemed to be unoccupied, While $H = H_1$ indicates that the licensed spectrum is deemed to be occupied [3].

The probability (P_{cd}) of correct detection of the presence of primary base station and the associated false alarm probability (P_{fd}) are denoted as

$$P_{cd} = \Pr (H = H_1/H_1),$$

$$P_{fd} = \Pr (H = H_1/H_0), \text{ respectively}$$

The missed detection of the presence of primary base station will result in interference between the secondary transmitter and secondary destination [5].

In order to guarantee that the interference imposed on the primary users is below a tolerable level, both the successful detection probability P_{cd} and false alarm probability P_{fd} should be within a meaningful target range.

Detection probability versus false rate:

False rate refers to the probability that a particular slot is decided to be occupied. Detection probability is the probability that free slot or occupied slot is detected

correctly. To calculate False rate and detection rate Monte Carlo simulations are run:

[Using probability to detect false rate]

Let x_j be the different value of x and P_j are list of their probability.

$$E[X] = \sum_{j=1}^j X_j P_j$$

$$P_j = \lim_{\#Realization \rightarrow \infty} \frac{(\#occurrence \text{ of } X_j)}{Realization}$$

$$\sum_{j=1}^j (\#occurrence \text{ of } X_j)$$

The input signal is the TDMA MIMO modulated signal effect of fading can be suppressed by diversity technique. Diversity can be achieved with the help of Multiple Input Multiple output system [7]. In cognitive radio network different users will have different SNR values.

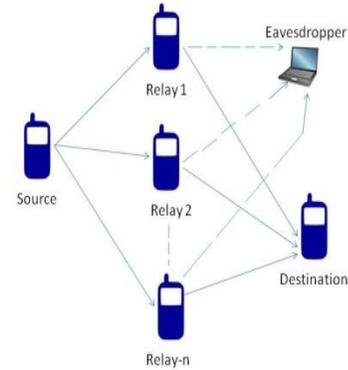


Fig 1:- A cognitive relay network consists of one source, one destination and number of relays in the presence of a snoop.

The TDMA modulated MIMO signals are transmitted through a Rayleigh fading channel [1].

OOBS and SBS Algorithm

The OOBS (On/Off Base Scheduling) technique is used in this method allows only those signals which are above the predefined SNR values. The SNR of the each user compared with the predefined value and acceptable signals only pass through the channel [3]. The SBS scheduling will allow the unacceptable signals if some part of the channels is ideal. These selection techniques will continue until the channel bandwidth utilization is full.

The power is efficiently allocated based on the SNR value of each user and given by the formula shown below.

$$\text{Power} = (1/\text{SNR} * \text{initial power}/\text{no of user})$$

The user with lowest SNR is allocated maximum power and the user with highest SNR allocated minimum power [10].

The hybrid decode amplify and forward relays are used for reducing the power needed for direct source to destination communication.

3:- RELAY SCHEMES

Amplify-and-Forward (AF) relay scheme

In this relaying scheme, the relay sends an amplified received signal to the fusion center in last time slot [3]. It requires much less delay because the relay node operates time-slot by time-slot. It also consumes less computing power because decoding or quantizing operation is performed at the relay side.

Decode-and-Forward (DF) relay scheme

In this scheme, the relay decodes the message in one block and transmits the re-encoded message in the next block.

Decode-Amplify-and-Forward (DAF) relay scheme

In this relay scheme cognitive radio detects received signal in the observation interval. If the decision is that primary user is absent, the cognitive radio keeps quiet and transmits only an indicator signal to the fusion center during its relaying time slot [9]. Otherwise, if the primary user is present, the cognitive radio amplifies the signal and forwards it to the fusion center [4]. According to the

decode amplify and forward scheme, every cognitive radio user performs detection and takes its own decision about the primary user. The source and destination nodes are fixed along with some intermediate nodes. The intermediate nodes act as the relay. Here the signals are chosen based on the SNR value.

If the signal's SNR value is greater than 20dB then those signals are acceptable, otherwise those signals are considered non-acceptable signals [12]. If the selected signal's bandwidth is equal to the channel bandwidth then all the signals are going through that channel to next level.

If the selected signals bandwidth is not equal to the channel bandwidth then the channel bandwidth is not properly utilized. By using the SBS scheduling technique the un-utilized bandwidth is used in a proper manner. High SNR signals are selected and passed to the channel. The signal selections are based on the SNR value and channel bandwidth.

4:- PROPOSED MODEL

Multi-Hop Relay Selection is the most common relaying approach in the disquisition is to select a relay to help a transmission from a sender to a destination. Here the MRC technique is used for relay selection. The clogging free shortest path from source to destination is found by using the routing algorithm. When applied to multi-hop networks, this method desires the repetition of the relay selection procedure for each hop from sender to destination.

However, such hop-wise harmony can reduce network capacity.

The operation of multi-hop relay selection approaches is as follows [6]: Potential relays access routing information creating a limited image of the network beyond the adjacent wireless links. Relays may decide to transmit overheard information to destinations, even in the absence of a direct link between the source and destination. Relays may have received the information to be relayed directly from the source or from other relays or intermediary nodes.

The destination node may receive more than two independent signals of the same packet e.g. via the selected relay node, via the intermediary node and directly via the source. This extra spatial diversity increases performance. We design a network with multiple nodes. First node behaves as a source and last node behave as a destination. From source to relay, decode and forward technique is chosen. This will help to reduce the error present in the transmitted signals, and retransmit to the next relay or destination. If the next node is a relay, then decode and forward is chosen else if the next node is destination, then amplify and forward is chosen. Amplify and forward is mainly used to amplify the received signals. So hybrid protocol is used to obtain secured data.

Expression for single relay

Calculation of on detection probability

Let P_f is the false alarm

P_m is miss alaram

P_d detection probability

$$P_{detection \text{ -probability}} = P_d * P_{on} + P_{off} * P_f$$

$$P_{on} = \frac{0.2}{0.8 + 0.2} = \frac{0.2}{1.0} = 0.2$$

$$P_{off} = \frac{0.8}{1.0} = 0.8$$

$$P_{on} + P_{off} = 0.2 + 0.8 = 1(1)$$

Since sum of probability is =1

$$P_{off_detect} = P_m * (1 - P_f) * P_{off}$$

The steps to be followed in the proposed technique are

Step 1: Random SNR Generation.

Step 2: Check the SNR value and choose the acceptable signals.

Step 3: Source to relay and relay to destination apply amplify and forward

Step 4: Again signal transmission

Step 5: Source to relay communication – decode and forward, Relay to destination communication –amplify and forward

Step 5: Final output

5:- Result

The X-axis represents the outage probability and Y-axis represents the intercept probability. From our proposed methodology the signal transmitted by single relay approach through source to

destination with and without hybrid approach.

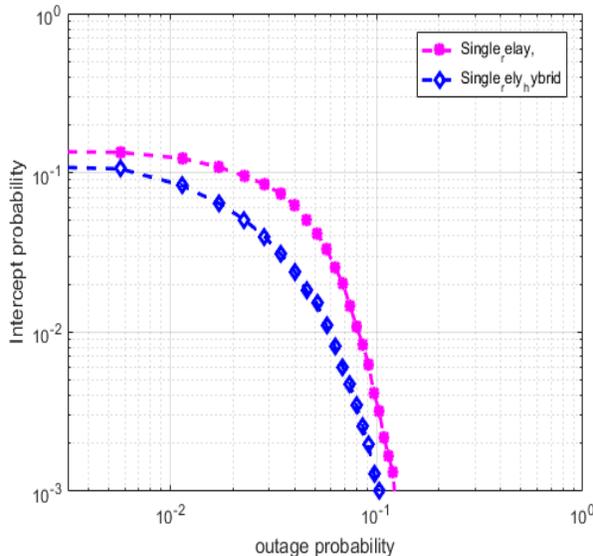


Fig 2:- IP versus OP of the single relay schemes for $(P_{cd}, P_{fd}) = (0.9, 0.1)$

Graph shows that as the spectrum sensing reliability $(P_{cd}, P_{fd}) = (0.9, 0.1)$. For an improved sensing reliability, an unoccupied licensed band would be detected more accurately and less mutual interference occurs, which results in a better security and reliability trade off. Result shows that Single relay hybrid approach gives better security and reliability trade off rather than decode and forward approach.

6:- Discussion

Cognitive network consisting of a secondary source, a secondary destination and multiple secondary relays in the presence of a snoop. We examined the security and reliability performance of the single relay hybrid approach assisted secondary transmissions in the presence of relay sensing and spectrum sensing. The security and

reliability of secondary transmissions are denoted in terms of IP and OP, respectively. The above results and analysis shows the importance of including the relaying links and the combining techniques into the performance analysis of cognitive networks. The novel approach to improve security and reliability by using hybrid approach.

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