A Brief Survey on Cooperative Network in Fading Environment

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Abstract-The wireless and interactive media applications are expanding, there is an unappeasable interest for more Cooperative spectrum. In any case, late investigations have uncovered that the greater part of the range is not any more accessible for wireless frameworks because of the distribution of the range under authorized band. Further, it is overviewed that the vast majority of the authorized range is either not utilized or under-utilized. Because of this natural wastefulness of flow range portion arrangements, and in addition the shortage of radio range, specialists throughout the years have proposed elective range access procedures to enhance the ghastly proficiency and capacity in radio communication, bringing forth the idea of "Cooperative Spectrum Sharing" . Thoughtfully, in Cooperative Sharing, a psychological user (unlicensed user) is permitted to exist together with the essential user in the authorized band, without corrupting the performance of the essential user.

Keywords-Cooperative Hybrid, Amplify and forward (AF), Decode and Forward (DF), hybrid scheme.

I. INTRODUCTION

Cooperative communication, introduction of relay channel generates few more independent paths between source and destination along with the direct link. The total communication process occurs in two stages namely broadcasting stage and cooperating stage. Cooperative communication is another new communication innovation in which a gathering of appropriated terminals are utilized to enhance spectral efficiency. In cooperative communication framework, every wireless user go about as a cooperative hand-off for another user and also ready to transmit its own information. the wireless user may build their viable nature of administration (throughput, BER, SER, unearthly proficiency and blackout likelihood and so forth.) by means of cooperation. Cooperative depending offers transmit assorted variety among single radio wire frameworks. In this way, lessens transmit power or expands the transmission extend for a given nature of administration (QoS).

In Fig. 1.1, we demonstrate a simple cooperative relay network comprising of three hubs, in particular source (S), goal (D) and a third node indicated as relay (R) which bolster the immediate communication amongst S and D. In the event that the transmission of a message from S to D over direct ink isn't completely fruitful, at that point the transmission from S to D is performed more than two transmission phases by means of the assistance of the relay. To begin with transmission is from S to R and the second transmission is from R to D.

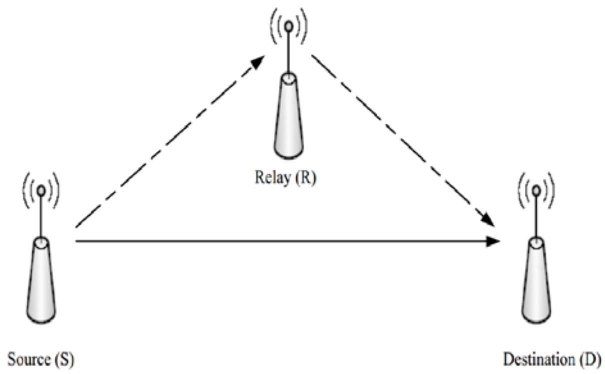

Figure 1.1 A simple Cooperative relay network.

- Cooperative Spectrum Sharing

Spectrum sharing protocols considering amplify-and-forward (AF) relaying have been proposed in [39], [40] and decode-and-forward (DF) relaying were investigated in. In, a cooperative relaying based spectrum sharing CR system to improve the spectrum efficiency considering constraints on the average received- interference at the PRx is investigated where AF relays are employed to help in the SUs communication process. There is no DL between source and associated destination nodes and the communication is established in a dual hop fashion with the help of a relay. End-to-end performance of the proposed system under different fading scenarios such as Rayleigh and Nakagami fading is also investigated.

- Decode and Forward Coding

In the one-way relay network operated under the DF protocol, the relay simply decodes the signal received from the source before forwarding to the destination. However, the relay in PLNC-based TWSRNs receives two data sequences simultaneously from two terminals. The challenging problem is how the relay decodes this mixed signal. Dealing with this problem, the first strategy was proposed in [23]. In this approach, the relay decodes the sum of two signals instead of decoding each signal individually. Thus, it was known as the DF- PLNC technique. The sum of any two signals was characterised by a point in a lattice. Based on this lattice, the relay can decode its received mixed signal and then forward it to both terminals. Using the DF protocol, this scheme does not suffer from noise amplification at the relay, and thus a higher data rate is expected. However, the generation of the lattice for mapping seems to be quite complicated for a general scenario where the signals transmitted from two terminals use different modulation and coding schemes. Also, this strategy requires synchronisation at the relay in both time and carrier when receiving signals from two terminals.

- Amplify and Forward (AF)

The relay only amplifies the mix of two signals received from two terminals, and then forwards this amplified version to both terminals. In the AF-PLNC technique, the relay performs processing upon the analog signals received from two terminals, and thus it was also known as analog network coding (ANC) [24]. Similar to the AF protocol for one-way relay networks, ANC has some advantages and disadvantages. The complexity at the relay using ANC is significantly reduced compared to DF-PLNC techniques. However, the performance and data rate could be affected since the noise at the relay is also amplified and forwarded to both terminals. Additionally, in order to extract the interested signal sent by another terminal from the mixed signal, channel information has to be estimated at both terminals to remove its own signal which is regarded as an interference to the interested signal.

II. COOPERATIVE HYBRID SPECTRUM SHARING

The main aim of this work is to provide a detail description of the system model of our proposed cooperative hybrid spectrum sharing protocol. The channel model considered in this work, adaptive power allocation schemes for both the PU and SUs as well as secondary transmission schemes with state transition scenarios are also presented respectively.

author consider a hybrid spectrum sharing model by jointly considering interweave and underlay schemes for CRNs consisting of a PTx and a PRx as well as a group of M STx-SRx pairs. The proposed system model is shown in Fig. 3.1. Secondary transmitters are divided into two groups. In the first group, K (K eM) active secondary transmitters STi, i e {1, 2,..., K} which may opportunistically use the PU spectrum or may transmit data with the coexistence of PTx below a certain interference threshold to the PRx. In the second group, N=M-K inactive secondary transmitters STj, j e {1, 2,..., N)} which are in idle state, act as relays to assist the primary system. Only the inactive secondary transmitters will participate in the relay selection procedure to cooperate the PU. At the same time, an active secondary transmitter may transmit its data to the corresponding receiver causing interference below the certain threshold to the PRx. The active secondary transmitter causes interference to the PRx when the DL between PTx and PRx exists or to the STj as well as the PRx during cooperation. Similarly, the PTx causes interference to the SRx when an active secondary transmitter transmits data to its corresponding receiver. Moreover, SUs or CRs interfere with each other when more than one SUs transmit simultaneously. When the data rate between PTx to PRx over a DL achieves RPT then the PTx directly transmits to the PRx which is shown in Fig. 3.1.

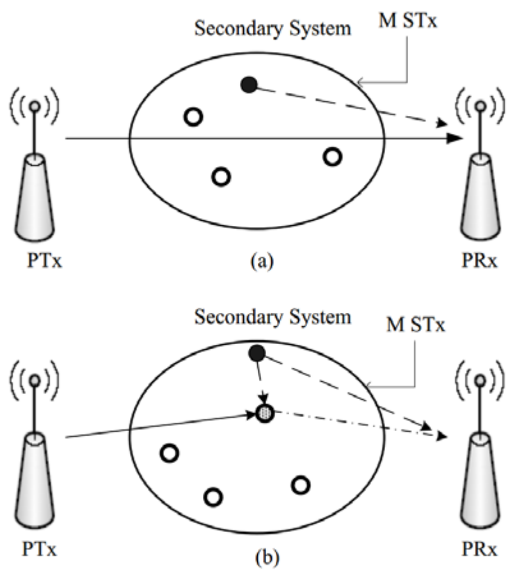

Figure 3.1 Cooperative Hybrid Sharing System.

- Hybrid Scheme

Hybrid solutions that combine the advantages of different approaches can be a promising solution to overcome the current spectrum under-utilization. For instance, the study in integrates the overlay scheme with the interweave scheme to form a protocol called credit-based overlay and interweave dynamic spectrum access. The use of this protocol has mainly focused on multi-hop wireless networks subject to two challenging design constraints: (1) PUs cannot be modified, and (2) the performance of PUs cannot degrade. Specifically, the study uses a notion of credits where SUs first help with the traffic delivery for PUs. In return, SUs are allowed to access the spectrum in a manner disruptive to PUs.

III. RELATED WORK

Sr. No.	*Title*	*Author*	*Year*	*Approach*
1	Enhancing the Physical Layer Security of Cooperative NOMA System	A. Li	2019	This system which adopts decode-and-forward (DF) consists of one base station (BS), M relays and two users
2	An ARQ-based protocol for cooperative spectrum sharing in underlay cognitive radio networks	S. Saraç and Ü. Aygölü	2016	In this paper, author propose a cooperative spectrum sharing protocol for cognitive radio networks (CRNs) which operate in underlay mode with an automatic repeat-request (ARQ)-based primary user (PU) including primary transmitter (PT) and primary receiver (PR) and a bidirectionally communicating secondary user (SU) which consists of the nodes S1 and S2
3	Interference free cooperative spectrum sharing in cognitive radio networks using spatial modulation	M. F. Kader and S. Y. Shin	2015	In this paper, authors present a novel cooperative spectrum sharing protocol using SM. A two phases uncoded decode-and-forward (UDF) relaying scheme is considered.
4	On the performance of multiple antenna cooperative spectrum sharing protocol under Nakagami-m fading	S. Sharma, A. Vashistha and V. A. Bohara	2015	In a cooperative spectrum sharing (CSS) protocol, two wireless systems operate over the same frequency band albeit with different priorities.
5	Exploiting multiple antenna cognitive radio system for cooperative spectrum sharing	A. Vashistha, S. Sharma and V. A. Bohara	2014	This paper proposes a cooperative spectrum sharing scheme in which multiple antennas of a secondary (aka cognitive) system is exploited to nullify the interference from the primary (aka licensed) to secondary system and vice versa.
6	An anti-interference cooperative spectrum sharing strategy with full-duplex	Weidang Lu, Jing Wang, Feng Li, Jingyu Hua, Limin Meng and Xinjian Zhao	2013	Author propose an anti-interference cooperative spectrum sharing strategy in cognitive two-phase full-duplex relaying networks.
7	Cooperative spectrum sharing with bi-directional secondary transmissions	Y. Pei and Y. C. Liang	2012	In this paper, author propose a new cooperative spectrum sharing scheme that allows bi-directional transmission of the secondary users (SUs) while serving as a relay to the primary link

A. Li., [1] In the future wireless communication networks, the key technique such as NOMA of 5G becomes prevailing. This paper analyzes the physical layer security of cooperative NOMA system. In analysis, this system which adopts decode-and-forward (DF) consists of one base station (BS), M relays and two users. In particular, a two-stage relay scheme is proposed, and analytical results are developed to demonstrate that this two-stage relay scheme can achieve the lower outage probability among all possible relay schemes, and realize the full diversity gain. The closed-form expression on outage probability is derived, as well as the asymptotic expression on outage probability is derived in the high SNR. Meanwhile, Monte-Carlo simulations are provided to demonstrate that cooperative NOMA with this two-stage relay scheme outperforms that based on the conventional max-min approach.

S. Saraç and Ü. Aygölü [2] In this paper, we propose a cooperative spectrum sharing protocol for cognitive radio networks (CRNs) which operate in underlay mode with an automatic repeat-request (ARQ)-based primary user (PU) including primary transmitter (PT) and primary receiver (PR) and a bidirectionally communicating secondary user (SU) which consists of the nodes S1 and S2. In ARQ-based PU, ACKnowledgement/Negative-ACKnowledgement (ACK/NACK) messages are sent from PR to PT and listened by S1 and S2 to control the PU's packet success. Si (i=1 or 2) alerts both PT and PR if its reception from PT is successed or failed and PR considers the link from Si or PT, respectively. PU transmits its packet by accessing the spectrum alone or by cooperating with SU or under an interference caused by SU. If PT transmits alone its packet successfully, in the next time slot it transmits a new packet in underlay mode during which SU access the spectrum simultaneously with a tolerable interference level to improves the PU's performance. Conversely, if PT fails to transmit alone its packet and at least one of the nodes S1 and S2 success to decode it, then S1 or S2 cooperates with PT attending as a relay to enhance the PU's throughput in the next time slot during which PT stays silent. If both of S1 and S2 fail to decode PT's packet, PT retransmits its packet in underlay mode. When the first transmission of PT's packet is failed in underlay mode, PT retransmits this packet alone. authors derive analytical expressions for the throughputs of PU and SU and show that the proposed protocol significantly improves the PU's throughput compared to non-CR scheme while stabilizing the SU's throughput at high SNR values.

M. F. Kader and S. Y. Shin,[3] Cognitive radio (CR) and spatial modulation (SM) are two exciting and emerging techniques to increase the spectrum efficiency for 5G. In this paper, authors present a novel cooperative spectrum sharing protocol using SM. A two phases uncoded decode-and-forward (UDF) relaying scheme is considered. A secondary transmitter (ST) consisting of Mt transmit antennas act as UDF relay for the primary system (PS). In the first phase, a block of information bits of the primary transmitter (PT) is mapped into two information carrying units: a symbol which is chosen from a constellation diagram and a particular antenna number from a set of transmit antennas. The ST is then uses iterative-maximum ratio combining (i-MRC) to de-map the transmitted block of information bits. In the second phase, the ST forwards the estimated primary data by activating only one antenna based on the own secondary data. The primary receiver is then uses i-MRC to estimate the forwarded primary symbol and the secondary receiver uses i-MRC to estimate own secondary data by detecting only transmit antenna indices of the ST. As a result, mutual interference between the PS and secondary system (SS) is avoided. authors investigate the bit error rate (BER) of the PS and SS. This research work show the efficacy of the proposed system.

S. Sharma, A. Vashistha and V. A. Bohara[4] In a cooperative spectrum sharing (CSS) protocol, two wireless systems operate over the same frequency band albeit with different priorities. The secondary (or cognitive) system which has a lower priority, helps the higher priority primary system to achieve its target rate by acting as a relay and allocating a fraction of its power to forward the primary signal. The secondary system in return is benefited by transmitting its own data on primary system's spectrum. In this paper, author have analyzed the performance of multiple antenna cooperative spectrum sharing protocol under Nakagami-m Fading. Closed form expressions for outage probability have been obtained by varying the parameters m and Ω of the Nakagami-m fading channels. Apart from above, author have shown the impact of power allocation factor (α) and parameter m on the region of secondary spectrum access, conventionally defined as critical radius for the secondary system. A comparison between theoretical and simulated results is also presented to corroborate the theoretical results obtained in this paper.

A. Vashistha, S. Sharma and V. A. Bohara[5] This paper proposes a cooperative spectrum sharing scheme in which multiple antennas of a secondary (aka cognitive) system is exploited to nullify the interference from the primary (aka licensed) to secondary system and vice versa. The secondary system also acts as a "decode-and-forward" relay for the primary system thus boosting its performance. The performance of primary and secondary system is analyzed by obtaining the closed form expressions for outage probability. The work are also shown to validate the theoretical expressions obtained in this paper.

Weidang Lu, Jing Wang, Feng Li, Jingyu Hua, Limin Meng and Xinjian Zhao[6] In this paper, authors propose an anti-interference cooperative spectrum sharing strategy in cognitive two-phase full-duplex relaying networks, in which the secondary system acts as a decode-and-forward relay to assist the primary system achieve the target transmission rate. As a reward, the secondary system can gain access to the licensed primary spectrum to transmit its own signal in both two phases. Since the two systems use different bandwidth to transmit their signals, there will be no interference effect between primary and secondary systems. authors study the joint optimization of the two-phase bandwidth allocation to maximize the received rate of the secondary system. wrok results are given to verify our analysis and illustrate the advantages of the proposed strategy.

Y. Pei and Y. C. Liang[7] In this paper, author propose a new cooperative spectrum sharing scheme that allows bi-directional transmission of the secondary users (SUs) while serving as a relay to the primary link. Specifically, author consider the network consisting of a primary transmitter PT, primary receiver PR and two SUs S1 and S2. Due to the unfavorable propagation condition of the primary link from PT to PR, the primary would like to seek help from the SUs to relay its signal. As a return, secondary terminals can gain opportunity for transmission. author propose a two-slot transmission strategy. In the first time slot, both PT and S2 transmit. In the second time slot, S1 will relay the primary signal as well as transmit its own signal to S2. Both the amplify-and-forward and decode-and-forward relay operations at S1 are considered. author derive the achievable rate regions for the sum-rate of the secondary links versus the primary link. Numerical results show that the proposed scheme can better explore the spectrum opportunity for the SUs as compared to the existing schemes. Furthermore, the improvement in spectrum utilization is not only from allowing the SU to transmit in the first time slot but also from the cooperation of the primary transmitter to control its power.

IV. PROBLEM IDENTIFICATION

Cooperative spectrum sharing (CSS) , which incorporates cooperative relaying and cognitive radio, has been proposed as an effective way to further improve the performance of the primary users as it helps to solve two fundamentals problem of wireless communication, i.e. limited coverage and spectrum scarcity. In CSS protocol [14], primary and secondary networks coexist in the same frequency band albeit with different priorities. The primary network which has higher priority seeks the assistance of low priority secondary network to improve its quality of service (QoS) in-exchange for allowing the secondary network to access its spectrum.

V. CONCLUSION

In this work the extensive survey on cooperative spectrum sharing with multi antenna and hybrid relay., author consider a cooperative wireless network in which relay either tries to improve the channel capacity of source to destination link using cooperative relaying protocols or reduce the channel capacity of source to eavesdropper link using jamming techniques. Optimal relay forwards the source information using cooperating relaying protocols such as decode and forward(DF), Amplify and Forward(AF) ,Hybrid decode amplify forward (HDAF) which combines the benefits of both DF and AF schemes. Among all the cooperating relaying schemes, HDAF relaying produces best results by employing, DF scheme until relay decodes the message perfectly and AF scheme if relay cannot be able to decode the message.

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