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Secure Energy Efficient Resource Allocation in NOMA Network with and without Cooperative Jamming

J. Micheal Louisa[1], T. M. Babi Mol[2]
[1]PG Scholar, Department of Electronics and Communication Engg., PET Engineering College, Vallioor, India
[2]Assistant Professor, Dept. of Electronics and Communication Engg., PET Engineering College, Vallioor, India

Abstract*: Secure communication is a promising technology for wireless networks because it ensures secure transmission of information. In this paper, we investigate the joint subcarrier (SC) assignment and power allocation problem for non-orthogonal multiple access (NOMA) amplify-and-forward two way relay wireless networks, in the presence of eavesdroppers. By exploiting cooperative jamming (CJ) to enhance the security of the communication link, we aim to maximize the achievable secrecy energy efficiency by jointly designing the SC assignment, user pair scheduling and power allocation. Assuming the perfect knowledge of the channel state information (CSI) at the relay station, we propose a low-complexity subcarrier assignment scheme (SCAS-1), which is equivalent to many-to-many matching games, and then SCAS-2 is formulated as a secrecy energy efficiency maximization problem. The secure power allocation problem is modeled as a convex geometric programming problem, and then solved by interior point methods. Simulation results demonstrate that the effectiveness of the proposed SSPA algorithms under scenarios of using and not using CJ, respectively.

***Keywords*: Cooperative Jamming, non-orthogonal multiple access, physical layer security, energy efficiency.**

1. Introduction

Recently, non-orthogonal multiple access (NOMA) has been considered as a promising solution to significantly improve energy efficiency for wireless communications. The main advantage of NOMA is that it can simultaneously serves multiple users on the same subcarrier (SC) to increase the system throughput. The concept of successive interference cancellation (SIC) at the receiver sides was applied in NOMA to address the inter-user interference. NOMA can utilize different resource allocation methods to achieve a good spectral efficiency and energy efficiency performance. In [6], the effective capacity with power control policy was introduced to guarantee delay quality of service (QoS) for downlink NOMA system. In [7], the power allocation techniques were studied to ensure fairness under instantaneous channel state information (CSI) and average CSI in NOMA system. In [8], user grouping based on user locations was applied to reduce interference and the power allocation scheme was employed to improve sum rate for visible light communication multi-cell networks.

Meanwhile, physical layer security has drawn much attention in wireless networks [9], [10]. Due to the broadcast nature of wireless communications, wireless transmissions are exposed to unauthorized users and vulnerable to both the jamming and eavesdropping attacks. Physical layer security is regarded as an important methodology to realize secrecy transmissions against eavesdropping attacks [11]. Specifically, secrecy capacity can be enhanced by exploiting multiple antennas additional spatial degrees of freedom in multipleinput- multiple-output (MIMO) wiretap channel [12], [13]. Furthermore, researchers applied robust beamforming transmission technique, artificial noise (AN), and Multi-antenna relay scheme to improve physical layer security [14]–[18]. Additionally, the physical layer security of cooperative communication in large-scale cognitive radio networks was investigated [19] by invoking a multiphase transmission scheme.

Cooperative jamming (CJ) is a special physical layer technique, which uses AN to confuse the eavesdropper. In [20], CJ nodes were studied and interfered untrusty relay nodes with splitted power. In [21], the distinct precoding vectors of nod users and jamming signals were designed in two-way relaying wiretap systems. In [22], secure transmission schemes were designed for relay network by exploiting CJ and signal superposition methods in two typical communication scenarios. One scenario is to maintain a satisfactory transmission rate while minimizing message leakage. The other scenario is to improve the average throughput of the system. In addition, an uncoordinated cooperative jamming scheme was investigated and uncoordinated single-antenna users independently transmit jamming signal. The central control properly allocated the jamming power of each helper to optimize secrecy sum rate [23].

Resource allocation plays a crucial role in exploiting the potential performance gain for NOMA wireless networks. Several works have employed different optimization methods to improve the sum rate in several research works, such as the monotonic optimization, Lagrangian duality theory, and matching theory. Besides the maximization of sum rate and resource allocation with security considerations for NOMA networks have also been addressed in the existing works. A robust resource allocation framework was investigated in half-duplex relay networks to improve the physical layer security. A secure cooperative communication was introduced in cognitive radio networks with users and eavesdroppers, where secondary users were allowed to access the spectrum of primary users in the presence of malicious eavesdroppers. The joint relay selection and subcarrier allocation scheme was employed in decode-and forward relay assisted secure vehicle-to-vehicle communications.

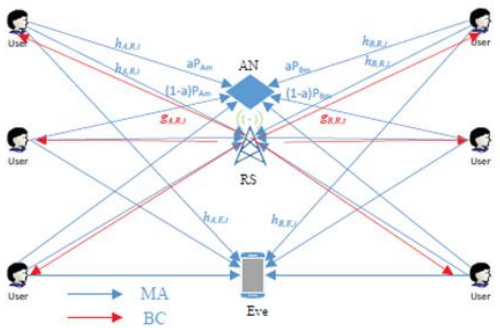

Fig. 1. System model of the security transmission in two-way relay wireless network

However, secure resource allocation has not been well studied for NOMA two-way relay wireless networks. These motivated our work. (1) the cooperative jamming is considered in secure energy efficient resource allocation in NOMA networks; (2) more simulation results are provided to verify the proposed methods with and without cooperative jamming.

In this paper, we consider secrecy energy efficiency maximization based amplify-and-forward (AF) two-way relay wireless networks under power constraints. To ensure the worst case secrecy energy efficiency for each user is a positive rate, we assume that an upper-bound capacity can be achieved for each eavesdropper. The eavesdropper is regarded as an untrusted user and the user pair patterns are known to eavesdroppers. The secure resource allocation problem is complex due to the combinatorial aspect induced by SC assignment and user pair scheduling and power allocation.

The rest of this paper is organized as follows. Section II provides the system model and problem formulation of secure resource allocation. In Section III, secrecy energy efficiency subcarrier assignment schemes for NOMA wireless network. In Section IV, secrecy energy efficiency power allocation scheme for NOMA wireless network. In Section V, performance of the proposed algorithms are evaluated by simulations. Finally, Section VI concludes the paper.

2. System model

In this project consider 2 secondary users at first primary user generate data then it was send to the secondary users after that super imposed encoding method is applied for encode the data and allocate the power for each user. Then perform multiplexing operation for combine encoding data and power. After that channel equalization method is used for calculate BER then perform decoding operation and finally calculate gain, achievable energy efficiency.

A. *Encoding*

The encoder structure for a superposition coding scheme with K layers. The high-speed binary

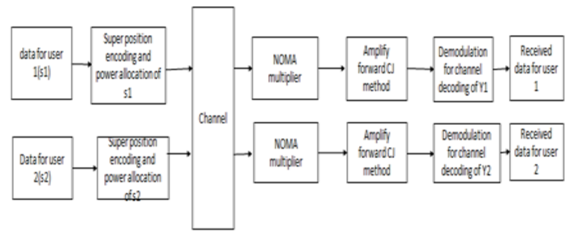

Fig. 2. Block diagram

where (0) ρ ρ k k> is an amplitude factor and θ k (0 /2 ≤ < θ π k) a rotation angle for layer-k. The overall rate i $R = 2\sum_{k=0}^{K-1} R_k$ in bits/symbol, where Rk is the rate of the kth binary component code. This scheme is also referred to as a multilevel coding/sigma-mapping scheme in [3], [4]. A notable feature of this scheme is the use of different amplitude factors {ρk} for the different layers, which is necessary to facilitate the decoding discussed later. The power allocation strategies developed in [3], [4] can be used to optimize {ρk}.

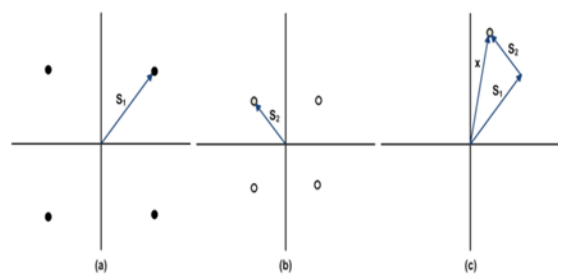

Fig. 3. An example of SC encoding (a) signal constellation of user 1 (b) signal constellation of user 2 (c) constellation of superposed signal.

Data sequence u is partitioned into K equal-length subsequences { ( ) k u }. The kth subsequence ( ) k u is encoded by a binary encoder (ENC-k) at the kth layer, resulting in a coded bit sequence $c^{(k)} = \{c_j^{(k)}\}$ with $c_j^{(k)} \in \{0, 1\}$. The randomly interleaved version v (k) of c(k) , from interleaver-k (INTL-k), is then mapped to a quadrature phase shifting keying (QPSK) sequence $x_j^{(k)} = x_{\mathrm{Re},j}^{(k)} + ix_{\mathrm{Im},j}^{(k)}$ according to $x_{\mathrm{Re},j}^{(k)} = 1-2v_{2j}^{(k)}$ and $x_{\mathrm{Im},j}^{(k)} = 1-2v_{2j+1}^{(k)}$, where $i = \sqrt{-1}$ and j is the time index. The subscripts Re and Im are used to denote the real and imaginary parts of complex numbers, respectively

The independent QPSK sequences are linearly superimposed to form the output signal:

B. *Iterative decoding*

We now develop an iterative decoding algorithm for clipped superposition coding systems. The main drawback of clipping is that it introduces additional noise at the transmitter [13]-[15]. If the clipping noise is not carefully treated at the receiver, significant degradation in the bit-error-rate (BER) performance may be observed, even when the clipping threshold A is moderate. On the other hand, in contrast to channel noise, the clipping noise is introduced by a process characterized by the clipping threshold. Exploiting this fact, we propose the soft compensation algorithm (SCA) to combat the clipping effect.

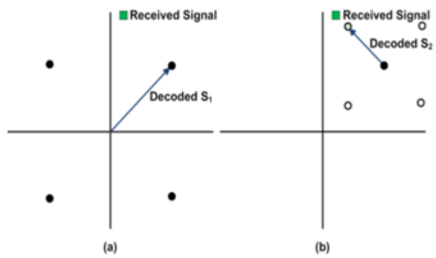

Fig. 4. An example of SC decoding (a) decoding the signal of user 2 (b) decoding the signal of user 1

C. Resource Allocation

In order to accommodate a diverse set of traffic requirements, 5G systems should be capable of supporting high data rates at very low latency and in reliable ways. However, this is a very difficult task, since resources are limited. So, resource management has to assist with effective utilization. Wireless resource management is a series of processes required to determine the timing and amount of related resources to be allocated to each user [61]. It also depends on the type of resources. According to the Shannon's information capacity theorem, BW is one of these wireless resources. As a part of the effective management of the system BW in a communications system, the total BW is first divided into several chunks. Each chunk is then assigned to a particular user or a group of users, as in the case of NOMA. Also, the number of packets for each user varies over 31 time. Therefore, user-pairing and optimum power allocation among users in NOMA requires a sophisticated algorithm to provide the best performance with the usages of minimum resources. Resource allocation in NOMA can also be explored from a mathematical optimization theory point of view. For example, Lei et al. considered joint power and channel allocation for NOMA in 5G networks in [62]. They take user power control and SIC implementation into account to solve the power and channel allocation problem. Power allocation in NOMA-based cognitive radio networks [63] is also an unexplored area of research.

1) Secrecy NOMA two-way relay wireless networks without cooperative jamming

We consider a NOMA two-way relay wireless network composed of M preassigned user pairs, denoted by M = {1, . . . ,M}. The NOMA channel composes of N SCs, denotedby N = {1, . . . ,N}, and each has a bandwidth B. As shown in Fig. 1, two users (Am and Bm), a RS, and an eavesdropper are presented. In the case of not using CJ, there is no artificial noise (AN). The bi-directional communications between users Am and Bmare aided by the RS. Eavesdropper is passive and intercepts the information from Am and Bm without alteration. AF protocol is considered in this paper which is divided into two phases: the multiple access (MA) phase and the broadcast (BC) phase. All user pairs do simultaneous wireless messages and power transfer with the RS in the MA phase; the RS further amplifies and forwards the received signals to user pairs employing its transmit power in the BC phase. Based on the CSI for NOMA two-way relay wireless network, one SC can be allocated to multiple user pairs, and one user pair can receive from the RS through multiple SCs. Meanwhile, the RS assigns different power to user pairs over SCs. Block fading channel is assumed to be flat and consisted of distance dependent path loss and Rayleigh fading on each of the SC. We assume a slow fading environment where all the SCs are invariable during a complete transmission cycle and co channel interference among user pairs on each SC is considered.

In the MA phase, we assume that SC iis allocated to the K user pairs, where K = {1, . . . ,K}. The mth user pair is composed of user Am and user Bm, where m ∈ K, m ∈M.
The received signal on SC iat the RS is given by

$$y_{RS,i} = \sum_{m\in\mathcal{K}} (\sqrt{P_{A_m,i}}h_{A_m,R,i}s_{A_m,i} + \sqrt{P_{B_m,i}}h_{B_m,R,i}s_{B_m,i}) + n_{RS,i} \quad (1)$$

where i∈ N; sAm,iand sBm,iare the transmitted signals of users Am and Bmon SC i, respectively, which are cyclic symmetric complex Gaussian (CSCG) random variables given by sAm,i∼ CN(0, 1) and sBm,i∼ CN(0, 1) separately; nRS,i∼ CN(0, σ2) is the additive white Gaussian noise (AWGN) at the RS on SC i. The total transmission powerof users Am and Bmare constrained by PAm and PBm, respectively; hAm,R,iand hBm,R,iare, respectively, the channel gains from Am to RS and from Bmto RS on SC i. The received signal at the eavesdropper on SC ican be expressed as

$$y_{E,i} = \sum_{m\in\mathcal{K}} (\sqrt{P_{A_m,i}}h_{A_m,E,i}s_{A_m,i} + \sqrt{P_{B_m,i}}h_{B_m,E,i}s_{B_m,i}) + n_{E,i} \quad (2)$$

where the channel gains on SC ifrom Am to the eavesdropper and from Bmto the eavesdropper are denoted by hAm,E,iand hBm,E,iseparately; nE,i∼ CN(0, σ2) is the AWGN on SC I at the eavesdropper. In the BC phase, we assume that SC j is allocated to the mth user pair with transmitted power PR,j. βiyRS,iis the signal transmitted from the RS, and $\beta_i = \sqrt{P_{R,j}}/\alpha_i$ is the amplifying coefficient. αiis a normalized factor denoted by

$$\alpha_i = \sqrt{\sum_{m\in\mathcal{K}} (P_{A_m,i}|h_{A_m,R,i}|^2 + P_{B_m,i}|h_{B_m,R,i}|^2) + \sigma^2}$$

The total transmission power of RSs are constrained by $\sum_{j=1}^{N} P_{R,j} \leq$ PR. The received signal on SC p j at Am is that $y_{A_m,i,j} = \sqrt{P_{R,j}}g_{A_m,j}y_{RS,i}/\alpha_i + n_{A_m,j}$, which can be further given by

Assuming co-channel interference among user pairs on each SC is considered. The signal-to-interference-plus-noise ratios (SINRs) of users Am and Bm, sharing SC iin the MA phase and SC j in the BC phase, which can be respectively given by

$$SNR_{A_m,i,j} = \frac{P_{R,j}|g_{A_m,j}|^2 P_{B_m,i}|h_{B_m,R,i}|^2/\alpha_i^2}{I_{A_m}+(P_{R,j}|g_{A_m,j}|^2/\alpha_i^2+1)\sigma^2}$$

And

$$SNR_{B_m,i,j} = \frac{P_{R,j}|g_{B_m,j}|^2 P_{A_m,i}|h_{A_m,R,i}|^2/\alpha_i^2}{I_{B_m}+(P_{R,j}|g_{B_m,j}|^2/\alpha_i^2+1)\sigma^2} \; .$$

2) Secrecy NOMA two-way relay wireless networks with cooperative jamming

Base on the CSI for the RS, we investigate a similar problem which is described in Section II-A with CJ. In the MA phase, s′Am,iand s′Bm,iare, respectively, the incorporating jamming signals of the users Am and Bmon SC ifor the exchange messages. The portions of the transmission power of the AN are denoted by α1,iand α2,i at Am and Bm on SC iseparately. Accordingly, Am splits its transmission power on SC iinto (1 − α1,i)PAm,ifor exchange message sAm,i, and α1,iPAm,i for AN, s′Am,i, respectively. Similar transmission scheme is used for Bm. The received signal on SC iat the RS can be expressed as

$$\begin{aligned} y_{RS,i} = \sum_{m\in\mathcal{K}} (&\sqrt{(1-\alpha_{1,i})P_{A_m,i}}h_{A_m,R,i}s_{A_m,i} \\ &+\sqrt{(1-\alpha_{2,i})P_{B_m,i}}h_{B_m,R,i}s_{B_m,i} \\ &+\sqrt{\alpha_{1,i}P_{A_m,i}}h_{A_m,R,i}s'_{A_m,i} \\ &+\sqrt{\alpha_{2,i}P_{B_m,i}}h_{B_m,R,i}s'_{B_m,i}) + n_{RS,i}. \end{aligned}$$

For the eavesdropper, the received signal on SC is given by

$$\begin{aligned} y_E^{(1)} = \sum_{m\in\mathcal{K}} (&\sqrt{(1-\alpha_{1,i})P_{A_m,i}}h_{A_m,E,i}s_{A_m,i} \\ &+\sqrt{(1-\alpha_{2,i})P_{B_m,i}}h_{B_m,E,i}s_{B_m,i} \\ &+\sqrt{\alpha_{1,i}P_{A_m,i}}h_{A_m,E,i}s'_{A_m,i} \\ &+\sqrt{\alpha_{2,i}P_{B_m,i}}h_{B_m,E,i}s'_{B_m,i}) + n_{E,i}. \end{aligned}$$

Assuming AN signals s′ Am,iand s′ Bm,i, which are fullyknown by the RS before being transmitted over some higher layercryptographic protocols, so

$$\sqrt{\alpha_{1,i}P_{A_m,i}}h_{A_m,R,i}\vec{s}_{A_m,i}$$

and $\sqrt{\alpha_{2,i}P_{B_m,i}}h_{B_m,R,i}s'_{B_m,i}$

As a result, only sAm,iand sBm,iare broadcasted on SC j in BC phase. Then, Am and Bmcan subtract sAm and subtract sBm to obtain desirable signal from the broadcast signal, respectively. However, eavesdropper suffers from large interference due to ANs are kept strictly confidential to the eavesdropper. After canceling s′Am,iand s′Bm,i, y′RS,i, whichtransmits the remaining signal be expressed as

$$\begin{aligned} y'_{RS,i} = \sum_{m\in\mathcal{K}} (&\sqrt{(1-\alpha_{1,i})P_{A_m,i}}h_{A_m,R,i}s_{A_m,i} \\ &+\sqrt{(1-\alpha_{2,i})P_{B_m,i}}h_{B_m,R,i}s_{B_m,i}) + n_{RS,i} \end{aligned}$$

The amplifying coefficient is denoted by $\beta_i = \sqrt{P_{R,j}}/\gamma_i$, where γican be regarded as a normalized factor for the forwarded signal. The transmit power of the RS on SC j is denoted by PR,j. Note that we can further simplify the received signal at the Am by substituting βi and y′RS,I due to Am can successfully cancel its previously transmitted sAm,i at its receiver.

For the eavesdropper, it receives a combined signal of sAm,Iand sBm,idue to the transmission signals are unknown, whichis expressed as

$$\begin{aligned} y_E^{(2)} = &\\ \sum_{m\in\mathcal{K}} (&\sqrt{(1-\alpha_{1,i})P_{R,j}P_{A_m,i}}h_{A_m,R,i}g_{R,E,j}s_{A_m,i}/\gamma_i \\ &+\sqrt{(1-\alpha_{2,i})P_{R,j}P_{B_m,i}}h_{B_m,R,i}g_{R,E,j}s_{B_m,i}/\gamma_i) \\ &+\sqrt{P_{R,j}}g_{R,E,j}n_{RS,i}/\gamma_i + n_{E,j}. \end{aligned}$$

The received signals at the eavesdropper during a transmit slot to the equivalent point-to-point 2-by-2 MIMO channel can be combined into

$$y_E = H_E{}' s + n_E{}'$$

For the eavesdropper, due to (28) is equivalent to a 2- by-2 point-to-point MIMO system with transmission signals $s' = \left[\, s'_{A_1,i} \;\; s'_{B_1,i} \;\; \ldots \;\; s'_{A_m,i} \;\; s'_{B_m,i} \,\right]^T$, denoted by s ∼CN(0, I). The maximum achievable received signal for theeavesdropper is defined as

$$\tilde{R}_{E,i,j} = \frac{1}{2}B\log_2\det\left(\boldsymbol{I} + \boldsymbol{H_E}\boldsymbol{H_E^H}\tilde{\boldsymbol{Q}}_{\boldsymbol{E}}^{-1}\right).$$

Hence, the worst-case secrecy sum rate with CJ for the mth user pair over the SC pair (i, j) can be denoted by

$$\tilde{R}_{\mathrm{sec},m,i,j} = [\tilde{R}_{A_m,i,j} + \tilde{R}_{B_m,i,j} - \tilde{R}_{E,i,j}]^+.$$

3. Energy efficient subcarrier matching scheme for NOMA

A. Subcarrier matching problem formulation

We first introduce the concepts of matching game, preferred matched pair, preferred matching. Considering the set of user pairs and the set of SCs as two disjoint sets of players aiming to maximize their own energy efficiency, formally presented as.

Definition 1: (Two-sided Matching) [38] Consider two disjoint sets, the user pairs M = {1, . . . ,M}, the SCs N = {1, . . . ,N}, a many-to-many mapping _, such that for every m ∈ M and SCi∈ N.

$$1)\Phi(m) \subseteq \mathcal{N}, \Phi(SC_i) \subseteq \mathcal{M};$$
$$2)|\Phi(SC_i)| \leq H, |\Phi(m)| \leq V;$$
$$3)SC_i \in \Phi(m), m \in \Phi(SC_i).$$

Condition 1) implies that each user pair is matched with a set of SC pairs and each SC pair is matched with a set of user pairs. Condition 2) states that each SC pair can occupy at most H user pairs, and each user pair can be assigned to at most V SC pairs. To better describe the operation process of each player, Condition 3) means user m and SCiare matched with each other. Definition 2: (Preferred Match Pair) Given any two subcarriers $SC_i, SC_{i'} \in \mathcal{N}, i \neq i'$ any one user pair m and two matchings $\Phi, \Phi', SC_i \in \Phi(m), SC_{i'} \in \Phi(m)$, if $E_{m,i}(\Phi) >$ $E_{m,i'}(\Phi')$ implies that user pair m prefers Similarly, given any two user pairs m,m′ ∈ M,m6= m′,and two matchings _, _′, m = _(SCi),m′ = _′(SCi), ifEm,i(_) >Em′,i(_′) implies that SCi prefers the user pairsm to m′.Since many-to-many matching is hard to achieve stable matching, we introduce the notion of switch matching asbelow.
Definition 3: (Preferred Matching) Given a matching _ withTwo user pairs in thesame subset exchange their matches in the opposite subset while other matches remain unchanged. Note that if a preferred matching is approved, then at least one player's data rates will increase, and the achievable rates of any player involved will not decrease at the same time.

B. Subcarrier assignment algorithm for NOMA

We formulate two SC assignment algorithms (SCAS-1 andSCAS-2). In SCAS-1, we assume that a larger CRNN of the SC has a higher priority to select user pairs. The preferred matching phase in SCAS-2, the RS keeps searching for two user pairs to form a match pair, then executes the preferred matching and updates the current matching if satisfied conditions. The iterations stop until no user pairs can form a new match pair.

4. Simulation results and discussion

In this section, we evaluate the performance of the proposed SSPA schemes with both SCAS-1 and SCAS-2 applied, and compare its performance with a random allocation scheme (RA-NOMA). We assume that two adjacent users are considered as a user pair, which selects the same SC. Each SC can be assigned to at most H = 3 user pairs, and each user pair can occupy at most V = 4 SCs. In the RA-NOMA scheme, the SCs is randomly allocated to the user pairs satisfying H ≤ 3 and V ≤ 4. For the simulations, the total of RSs peak power Ps is 46dBm, system bandwidth is 4.5MHz and the transmit power for each user is PAm = 300mW, PBm = 300mW on the uplink. We assume that noise power spectral density is -150 dBm/Hz, circuit power consumption Pc = 1dB and eavesdropper is allocated at a distance of 500 m from the RS, if there is no special instructions. Pass loss functions can be obtained by hata urban propagation model [39]. The coverage radius of the RS is r = 30 m and user pairs are evenly distributed in a circle around the central RS. Considering the computational complexity, we assume that there are 10 SCs in the NOMA wireless network.

We investigate secure communications for NOMA twoway relay wireless networks in the presence of eavesdroppers under scenarios of using and not using CJ at the relay station (RS). Here randomly generate the input data with number of transmitted bits 100 for primary user, secondary user1, secondary user 2.

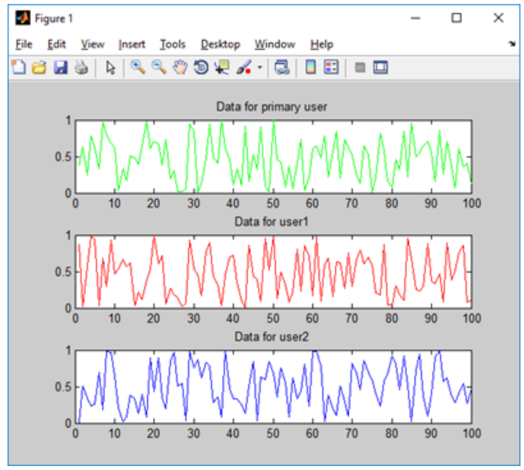

Fig. 5. Input signal for users

Super position encoding method is used for encode the input signal. In secure transmission schemes were designed for relay network by exploiting CJ and signal superposition methods in two typical communication scenarios.

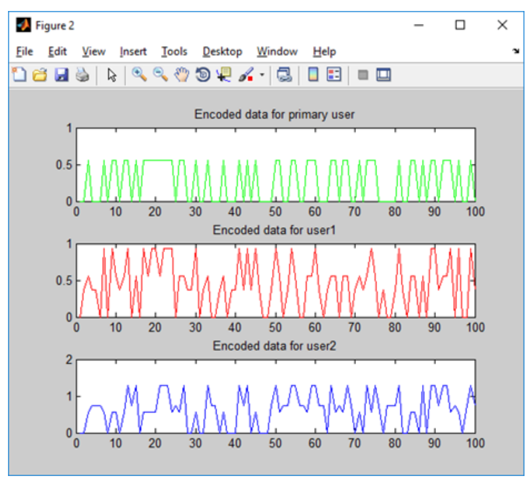

Fig. 6. Superposition encoding data

For transmitted signal apply 0.01 noise variation and combine primary user and secondary users signal. Then received the signal through the atmospheric channel.

The Fig. 7, show that the received data from primary user and secondary users from base station. Here allocate power for primary user 0.5, secondary user1 0.2 and secondary user2 0.3. After that apply NOMA multiplier process. In which multiply power with randomly generated input signal.

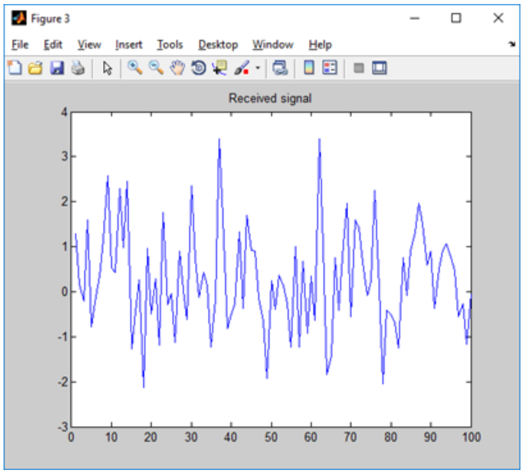

Fig. 7. Transmitted signal through channel

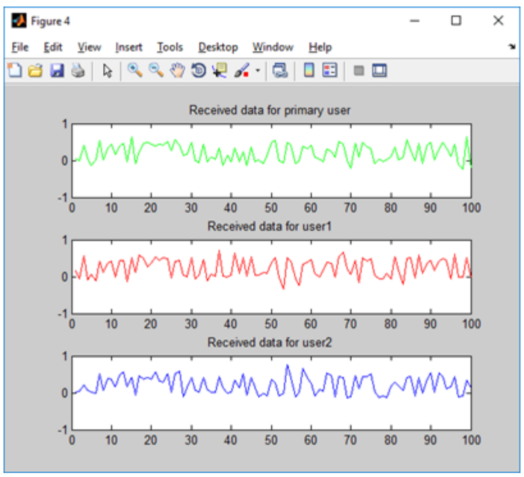

Fig. 8. Received signal

The Fig. 9, shows that the BER vs. SNr here when BER decreased increase the SNR value. For this process we have to obtain 32*10^(-5) dB SNR value

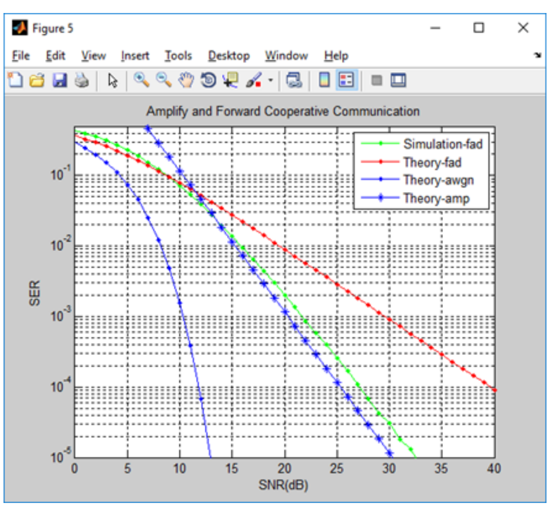

Fig. 9. SER vs. SNR

Resource allocation plays a crucial role in exploiting the potential performance gain for NOMA wireless networks. Several works have employed different optimization methods to improve the sum rate in several research works. Here apply amplify forward 2 way rely network to improve the gain and sum rate value.

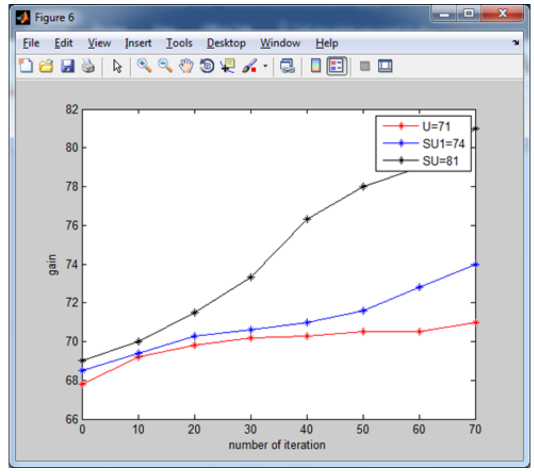

Fig. 10. No. of iterations vs. Gain

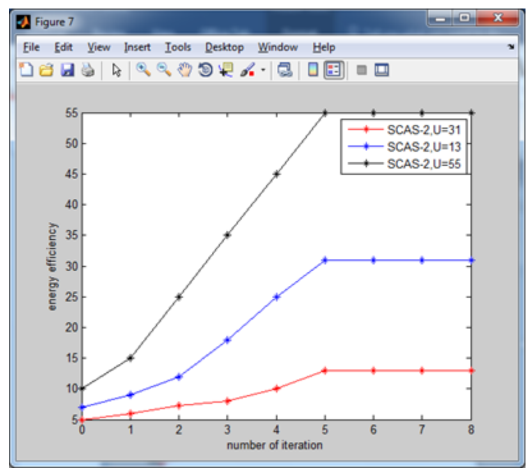

Fig. 11. No. of iterations vs. Energy efficiency

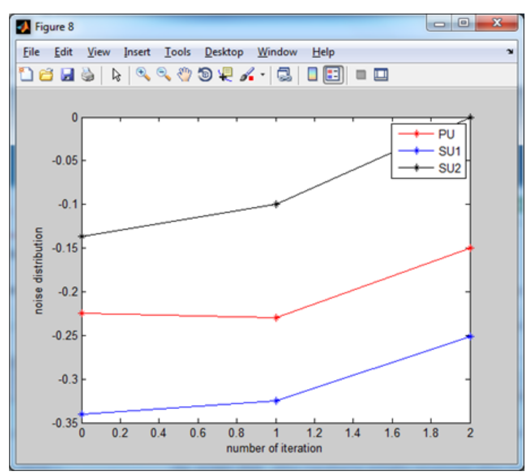

Fig. 12. No. of iterations vs. Noise distribution

The Fig. 11, show that the energy efficiency of each users. Here we obtain maximum 55% of energy efficiency. The secrecy energy efficiency performance vs. the number of iterations for the proposed algorithm. We can see that the proposed SSPA algorithms based power allocation algorithm (Algorithm 3) takes at most 10 iterations to converge. The energy efficiency goes up sharply with 1 iteration, and then it closes to a relatively stable level when the number of iterations over 1 time.

The Fig. 12, shows that the noise distribution. Here we have to reduce the system noise compared with previous method.

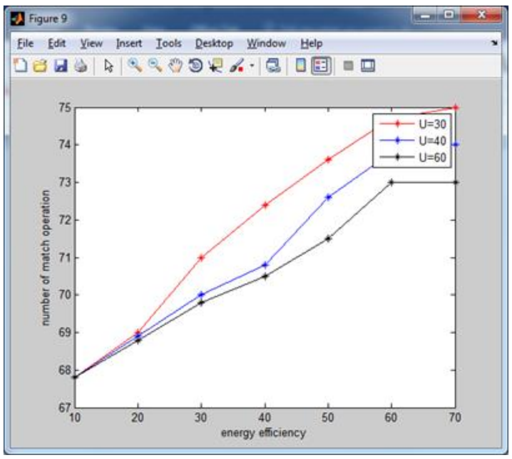

Fig. 13. Energy efficiency vs. No. of match operation

The Fig. 13, shows secrecy energy efficiency performance vs. the number of match operations in the SCAS-2 scheme. When users become larger, the number of match operations become higher due to more user pairs have the opportunity to be serviced by the RS. We can see energy efficiency increases with the match operation number increasing within 40 match operations. The energy efficiency closes to a relatively stable level when match operation number over 40 match operations which implies the proposed SCAS-2 scheme also has a low complexity.

Here we have to apply demodulation process by qpsk method and decoding the data by super position decoding method

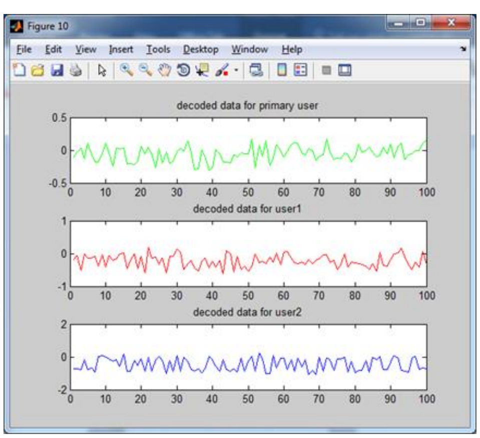

Fig. 14. Super position decoded signal

Table 1
Parameters

Parameters	Primary user	Secondary user1	Secondary user2
Energy	31.03	13.79	55.17
Sum rate	0.8853	0.8861	0.8857
System loss	1.24	1.69	1.04
Attenuation gain	0.76	0.82	0.72

SNR = 32*10^(-5) dB

5. Conclusion

In this paper, we investigated the secure SC assignment and power allocation for the NOMA two-way relay wireless networks in the presence of an eavesdropper without and with CJ. The proposed SSPA algorithms with SCAS applied properly allocate resources to user pairs, and the performance of secrecy energy efficiency of the system can be significantly improved than the RA-NOMA scheme. Moreover, the SSPA-2 scheme thoroughly outperforms the SSPA-1 scheme.

For future work the downlink of an Orthogonal Frequency Division Multiplexing based Non Orthogonal Multiple Access system where transmission to multiple number of users is performed on the same sub-band (time-frequency resource unit) using Superposition Coding (SC) technique. At the receiver side, the SC coded symbols are recovered with Successive Interference Cancellation (SIC). For each of the sub-bands, a greedy user selection and iterative sub-optimal power allocation algorithm based on Difference of Convex (DC) programming is presented. Simulation results are provided to assess and compare the performance of the proposed algorithms.

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