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PERFORMANCE ANALYSIS OF CHANNEL AND POWER ALLOCATION IN OFDMA BASED MU-RELAY NETWORKS

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Abstract: - Radio resource allocation plays a vital role in case of multi-users, multi-relay orthogonal frequency division multiple access (OFDMA) based systems. Let us consider an OFDMA based wireless relay networks where multiple user pairs exchange information via multiple relays using full duplex communications. The optimization problems like channel allocation, power allocation and relay selection can be formulated as a mixed integer programming problem. Proposed efficient optimal resource allocation algorithm is formed to minimize total transmit source power per subcarrier and number of relays with required data rates. Simulation results prove that the proposed optimal [5] method can improve OFDMA based multi user relay networks significantly with required data rates.

Keywords - OFDMA, CSI, AF, DF, RELAY

1. Introduction

An OFDMA is one of the most important emerging transmission techniques for future wireless communication systems. The overall performance of the wireless networks can be improved by using relay[3] networks. The performance includes wide coverage area, power saving, and total throughput with minimum deployment cost. An orthogonal frequency-division multiple access (OFDMA) combined with relay networks offers one of the powerful technique to enable high date rates over wireless communication systems. OFDMA based relay have an ability to access multiple channels. It may transmit a processed version of the signal to another subcarrier which is received from one subcarrier. We are proposed Adaptive subcarrier allocation algorithm to achieve maximum sum rate capacity for an OFDMA based a multiple user multiple relay.

Let us consider the optimizing problems that will occurs in incoming and outgoing subcarriers in multichannel relay networks, maximize the data rate in a end to end multi hop relay networks. The resource allocation problem that will occur in an OFDMA based multi user two way communication networks can be done by proposing optimization algorithm to maximize the rate sum capacity. Frequency diversity feature of OFDMA based multi user relay

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networks can be used by subcarrier paring. It improves system performance by comparing incoming and outgoing subcarriers at the relay station based on dynamically varying nature of the channel.

In an OFDMA based multi user relay networks, particular subcarrier is selected by the relay having highest signal to noise ratio. Relay selection can be done by subcarrier manner. We can select different relays for different subcarriers at each hop.

2. System model

Relays play an important role in wireless communication particularly in cellular networks to increase the coverage area, reduce the total transmission power, enhance the rate sum capacity of a specific region with high traffic demands and improve signal reception.

2.1 System Model of OFDMA based MU Relay Networks

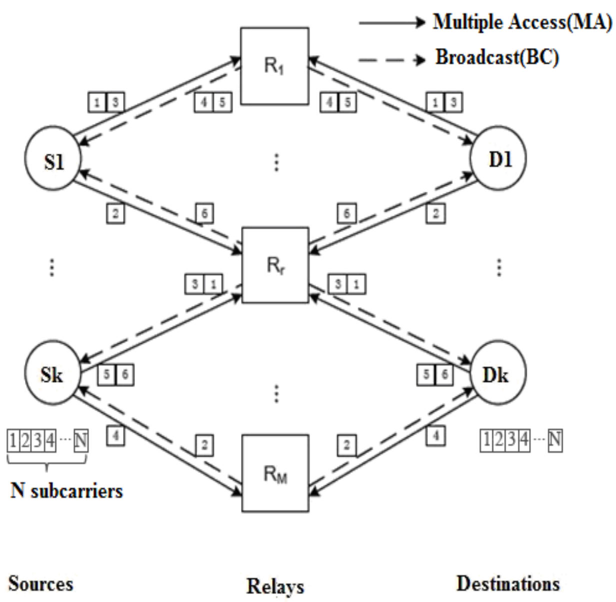

Figure 1. Block Diagram of OFDMA based MU Relay networks

Consider an OFDMA based multi user relay [1] networks shown in figure in 1.It has 'k' equal number of sources and destinations which are interfaced with 'M' number of relays. Sources and destinations assumed to be users. Each source having 'N' number of subcarriers which is distributed and sent to different relays. Finally we can reassemble it in the destination. Each pair of source and destination exchange information via the relays. Each node (source, relay and destination) operates in a half-duplex mode. There are two terminologies multiple access (MA) and broadcast (BC) are available in OFDMA based multi user relay [8] networks. In multiple access terminology all the pairs of source and destination transmits the signals to the relay nodes at the same time. In broadcast terminology relay nodes amplifies the signal which is received from source then forward to the destination. Each relay node is assumed to be operated as non overlapping subcarriers principle.

The function of relay can be done in different ways. They can be grouped as AF relaying, DF relaying and EF relaying.AF (Amplify & Forward) relay [7] amplifies the signal which is received from source then forward to the destination.DF (Decode & Forward) relay [7] decodes the signal which is received from source then forward the error free of decoded signal to the destination.EF (Error & Forward) relay decodes the error signal which is received from source then forward the error of decoded signal to the destination. Let us assume that channels exists between different links may experience independent fading. So channel state information (CSI) is important in wireless fading environment.

3. Design Methodologies

Effective channel and power allocation [4][6]algorithms are needed in order to maximize the rate sum capacity of relay networks by considering the two criteria channel state Information and bit error rate (BER). Relay based systems uses the radio resources channel, power, subcarrier to improve the performance like total throughput [3] and less bit error rate. Power can be minimized by reducing the total transmit power for a given sum data rate.

Let the source has the perfect channel state information (CSI) then group of subcarrier channel can be given to relay networks then processed information from relay networks transferred to destination. Each subcarrier is characterized by the channel gains. The optimization problem by mathematically

$$\max_{\rho^n_{k,m}, R^n_{k,m}} \sum_{k=1}^{K}\sum_{m=1}^{M}\sum_{n=1}^{N} \rho^n_{k,m} R^n_{k,m} \qquad (1)$$

Subject to

$$\sum_{k=1}^{K}\sum_{n=1}^{N} p^n_{S_k} \le P_{k,total}$$

$$\sum_{k=1}^{K}\sum_{n=1}^{N} p^n_{D_k} \le P_{k,total}$$

$$\sum_{m=1}^{M}\sum_{n=1}^{N} p^n_{R_m} \le P_{R,total}$$

$$p^n_{S_k}, p^n_{D_k}, p^n_{R_m} \ge 0 \quad \text{for all k, m, n}$$

$$\rho^n_{k,m} = \{0,1\} \quad \text{for all k, m, n}$$

Where

- K - Total number of user pairs
- M - Total number of Relay nodes
- N - Total number of Subcarriers
- $\rho^n_{k,m}$ - Subcarrier assignment indicator
- $R^n_{k,m}$ - Rate sum capacity of k^{th} user
- $p^n_{S_k}$ - Transmit power of k^{th} user of n^{th} subcarrier on source side
- $p^n_{D_k}$ - Transmit power of k^{th} user of n^{th} subcarrier on destination side

$p^{n}_{R_m}$ - Transmit power of m^{th} relay of n^{th} subcarrier on relay nodes

$P_{k,total}$ - Total Transmit power of k^{th} user

$P_{R,total}$ - Total Transmit power of R^{th} Relay

4. Proposed Methodology

The implementation of proposed algorithms for Channel allocation and Power allocation is compared with existing algorithms how close they come to the optimum allocation [2][5] and how quickly they reach their final allocation.

4.1 Proposed Channel Allocation

The channel assignment is made between Source user and relay nodes as well as Relay nodes and Destination user. Only one channel is formed between Source user and relay nodes as well as Relay nodes and Destination user.The relay plays an important role to make channel pairing and channel user assignment. Channel pairing related to a connection between incoming channels and outgoing channels at the relay nodes. Channel user assignment related to a subset of incoming and outgoing channels is assigned to each user.

The optimization problem for Channel allocation can be formulated by the following expression

$$C = \max \sum_{k=1}^{K} \sum_{m=1}^{M} \sum_{n=1}^{N} \phi_{k,m,n} A_{k,m,n}(\lambda) \qquad (2)$$

Where

$\phi_{k,m,n}$ - Channel assignment indicator

$A_{k,m,n}(\lambda)$ -Channel assignment parameters

λ - Lagrange multipliers

4.2 Proposed Power Allocation

After the channel assignment, we can allocate the power according to channel state information.

Transmit power of k^{th} user of n^{th} subcarrier on source side $p^{n}_{S_k}$ is given by

$$p^{n}_{S_k} = \sum_{k=1}^{K} \sum_{n=1}^{N} (1-\alpha_k)\left(p^{n-1}_{S_k} - 0.5\right) P_{k,total}$$

Transmit power of k^{th} user of n^{th} subcarrier on destination side $p^{n}_{D_k}$ is given by

$$p^{n}_{D_k} = \sum_{k=1}^{K} \sum_{n=1}^{N} (1-\beta_k)\left(p^{n-1}_{D_k} - 0.5\right) P_{k,total}$$

Transmit power of m^{th} relay of n^{th} subcarrier on relay nodes $p_{R_m}^{n}$ is given by

$$p_{R_m}^{n} = \sum_{m=1}^{M}\sum_{n=1}^{N}(1-\beta_k)\left(p_{R_m}^{n-1} - 0.5\right)P_{R,total}$$

Where

$\alpha_k, \beta_k, \gamma_k$ - Lagrange multipliers

5. Simulation Results

The overall performance of the wireless networks can be improved by using relay networks. The relay plays a vital role to make channel pairing and channel user assignment [9]. Allocation of power [10] can be done according to channel state information. The performance of proposed algorithm can be shown in the simulation results by using MATLAB 7.9.The simulation parameters are Total number of user pairs K=20, Total number of relay nodes M=20, Total number of subcarriers N=256, Total power = 0.75 watt.

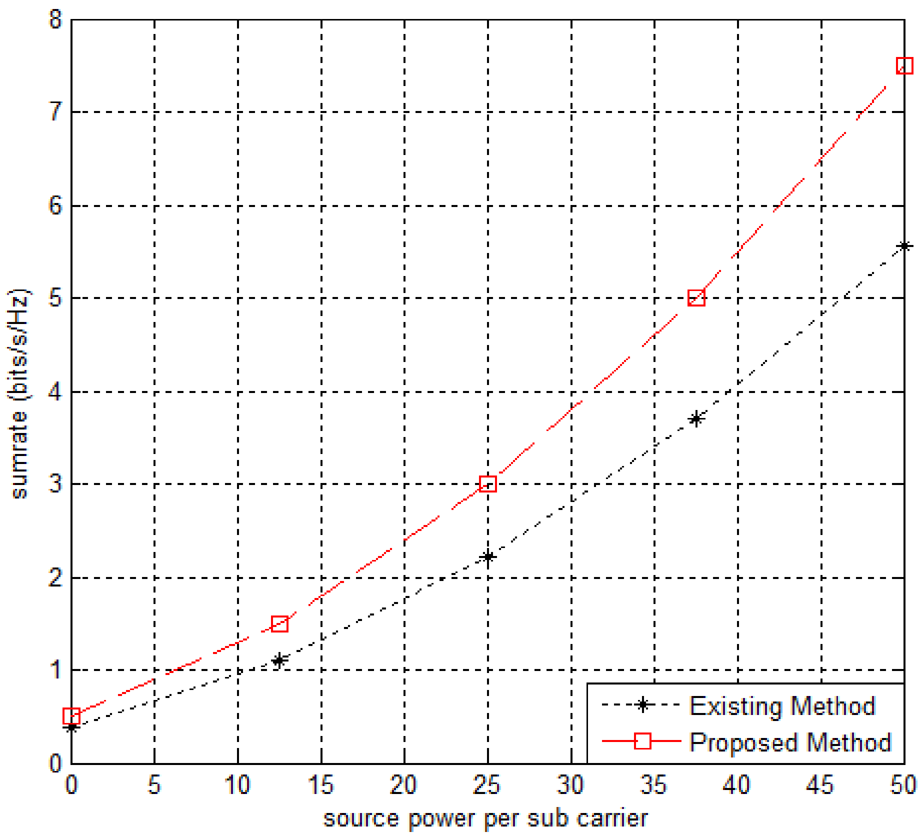

Figure 2. Power per subcarrier V_s Maximum Rate sum Capacity of user

Figure 2 shows the simulation result of Power per subcarrier versus Maximum Rate sum capacity of user.

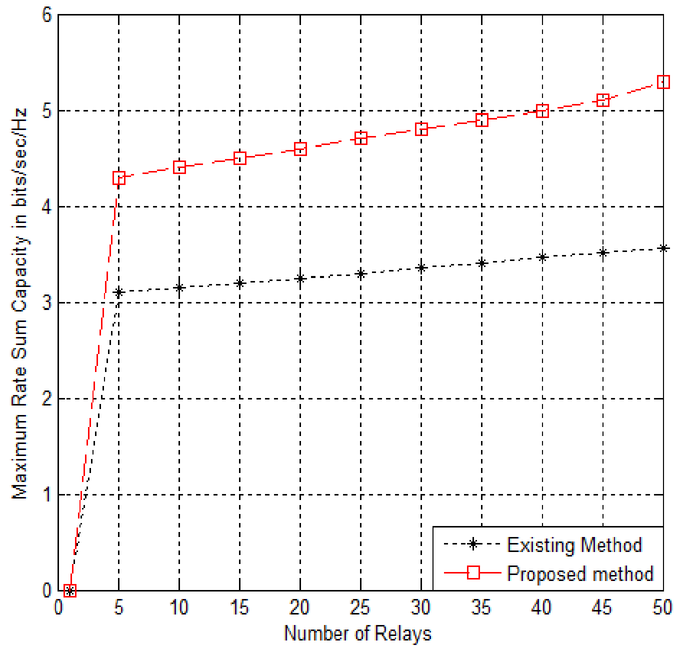

Figure 3. Number of relays V_s Maximum Rate Sum Capacity of user

Figure 3 shows the simulation result of Number of relays versus Maximum Rate sum capacity of user.

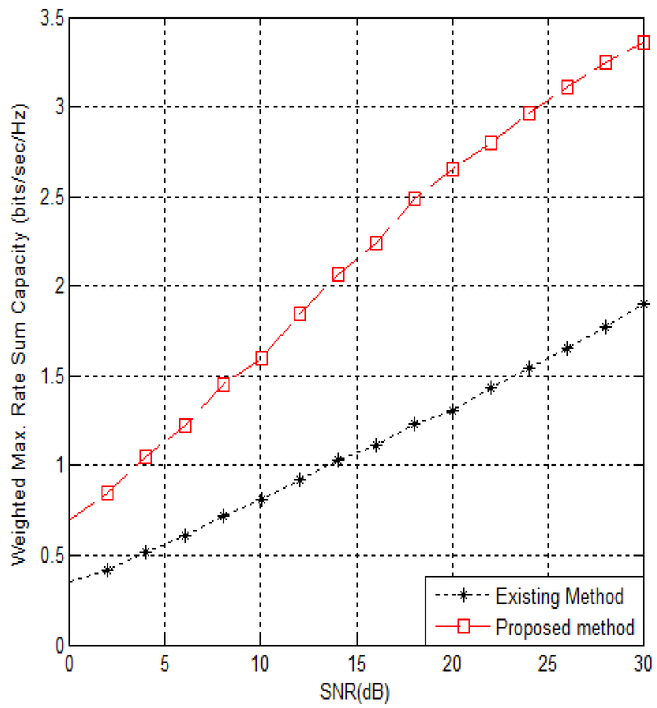

Figure 4. Signal to noise ratio V_s Weighted Max. Rate Sum Capacity of user

Figure 4 shows the simulation result of Signal to noise ratio versus Weighted Maximum Rate sum capacity of user.

6. CONCLUSION

From the simulation results we can conclude that the proposed optimal method can improve OFDMA based multi user relay networks significantly with required data rates. In future work we can extend the same work for increasing total number of user pairs K, total number of relay nodes M,total number of subcarriers N and reduced total power with necessary conditions for optimization which enhances the Rate sum capacity of user with low computational complexity, providing almost near to optimal solutions.

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