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IMPROVED RESOURCE ALLOCATION FOR CO-OPERATIVE OFDMA WIRELESS NETWORKS

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Abstract: - Wireless networks use two or more wireless hops to convey information from source to destination. Orthogonal Frequency Division Multiple Access (OFDMA) is an multi-user version and multiple accesses that can be ensured by allocating the subsets of subcarrier. The resource allocation is a very prominent concept in the network applications by providing shortest path, energy allocation, lower computation overhead and higher response time. In the existing scenario, resource reuse methods are used in the OFDMA networks .The dynamic intra-cell subcarrier reuse in cooperative OFDMA networks, the users are permitted to distribute any subcarrier in the relay links provided that the resultant intra-cell interference is managed. Particularly, while the target data rates of the users are not reachable in the traditional cooperative OFDMA network, dynamic intra-cell subcarrier reuse permits the users to ensure their objective data rates. The subcarriers are permitted to reuse in the communicate associations in order to maximize the system sum-rate subject to per node power and desired data rate conditions in a cooperative OFDMA single cell network. However, OFDMA with suboptimal resource allocation has issues with high complexity algorithms and also with the distributed implementation of the resource allocation techniques. Improved resource allocation technique is used to overcome this issue by using the concept of minimization of resource allocation with neighbour nodes while in the distribution environment. This technique is used to improve the relay link along with maximum gain for high data rate users and also improves the power reduction as well as developing the resource allocation more effectively than existing scenario.

Keywords: Resource Allocation, OFDMA, OCA, MC-CDMA, ISRAA of AF.

1.1 INTRODUCTION

Wireless communication is used for transferring the information between two or more nodes. Usage of mobile phone is increasing in day todays life. Mobile phones needs small amount of power and compact antenna. Base station pick up the weak signal from the phone and relay it onwards another phone mast which is nearer to destination. There is only limited number of radio frequencies available on the mobile network. Mobile phone conversation requires one frequency for transmission and another frequency for reception. Cells which divides the land in which same frequencies can be reused by each other. Cell site has the base station with about 800-1900MHZ for both transmitting and receiving antenna. The radio equipment provides the coverage from an area that is usually two to ten miles in radius. Depending upon the cell sit the area is covered. OFDMA and relay enhanced wireless networks are used to provide the ubiquitous coverage and high data rate in the future wireless networks. In OFDMA all users communicate with the base station directly without the relay links. Relay enhanced OFDMA systems increases the coverage area and system performance in most effective manner. User can transmit the data through direct links and relay links. Direct link is identified by subcarrier and relay link is identified by both subcarrier and relay node. There are two different types of relaying schemes. Amplify and Forward (AF), the relay node amplifies the received signal and transmits to the destination. Decoder and Forward (DF), relay node decodes the received signal in to binary data after re-encoding the data it transmits to the destination. The main aim of the resource allocation in OFDMA systems, from user's prospect is to maintain each user's target data rate. In case of system's prospect is to maximize the sum rate and minimize the total power. In this the sufficient number of subcarriers are allocated to each user (even to a user with a poor channel gain on all subcarriers) to support its target data-rate at the cost of decreased system sum-rate, whereas in the latter each subcarrier is allocated to the user with the best channel gain on that subcarrier to maximize the system sum-rate at the cost of unfairness. Subcarriers are allocated to each users. The available subcarriers are commonly reused in the relay enhanced OFDMA in the wireless networks to improve the spectral efficiency. Subcarriers are not pre-allocated to the cell sectors, but they can be dynamically reused in the relay links based on the users channel state.

1.2 EXISTING METHOD

In the existing scenario, the methods are introduced to handle the issues of high data rate in wireless networks. The technique introduced based on the orthogonal frequency division multiple access (OFDMA) which deals with efficient resource allocation. In a relay-enhanced OFDMA system, in addition to subcarrier and power allocation, it is also decided who helps whom, with what method, and what extent. In a relay-enhanced OFDMA network, the users transmit through two types of links: direct links which are the links from the users to the base station, and relay links which are the links from the users to the relay nodes. For a given user, a direct link is identified by a subcarrier while a relay link is identified by a subcarrier and a relay node. Relaying may be carried out by some fixed relay stations deployed across the cell, or by users themselves in a cooperative manner.In this considering the decode and forward (DF) method, the relay node first decodes the received signal into binary data and then after reencoding the data, transmits it to its destination. The objective of resource allocation in OFDMA systems from a user's prospect is to support each user with its target data-rate, whereas that from a system's point of view is to increase the system sum-rate and reduce the total power.

1.2.1 DRAWBACKS

1. It has still issue with complexity algorithms
2. It does not suitable for distributed implementation of resource allocation.
3. It degrades the system performance

1.3 PROPOSED METHOD

In proposed method, the optimal resource allocation has been done by improved resource allocation. It uses the prominent resources for the distributed manner implementation based on the cooperative resource allocation in wireless networks. The objective is the computation of efficient allocations, while accounting for wireless node interference. The path forward is towards cooperative approaches that dissuade malicious behaviors in setting demands under an adequate binding agreement fixing common rules on shared information and allocation scheme. It considers amplify and forward (AF) scheme which relay node simply amplifies the received signal and transmits it to its destination. Considering the improved resourced allocation method along with AF scheme can allocate the sufficient and efficient resources for distributed implementation. It is used to reduce the total power consumption than the existing scenario. It also improves the complexity reduction and increases the system efficiency significantly. This method discovers probable user cooperation path to execute improved resource allocation in OFDMA wireless networks. To compute the consumption of each node with nearest neighbor node. It is used to avoid the congestion in the wireless network and performance degradation. The channels for different users in each subcarrier are allocated and reusable subcarrier is determined more effectively. It develops the speed of the distribution process and all nodes can utilize efficient resources on time. The result shows that proposed system is better in overall performance.

1.3.1 ADVANTAGE

1. The complexity is reduced significantly
2. Distributed implementation of resource allocation has been done effectively
3. It improves the system performance in superior
4. The best channel selection is performed
5. It consumes minimum amount of time, energy and effective resources

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1.4 SYSTEM IMPLEMENTATION

1.4.1 CREATION OF NETWORK MODULE

An undirected graph G (V, E) where the set of vertices V represent the mobile nodes in the network and E represents set of edges in the graph which represents the physical or logical links between the sensor nodes. Sensor nodes are placed at a same level. Two nodes that can communicate directly with each other are connected by an edge in the graph. Let N denote a network of m sensor nodes, $N_1, N_2, \ldots N_m$ and let D denote a collection of n data items $d_1, d_2, \ldots d_n$ distributed in the network. For each pair of sensor nodes N_i andN_j, let t_{ij} denote the delay of transmitting a data item of unit-size between these two nodes.

1.4.2. SUBOPTIMAL RESOURCE ALLOCATION ALGORITHM FOR PHASE 1

In phase 1, while attempting to reuse the subcarriers in the relay links, the subcarriers are allocated to the users in I in the relay or direct links to satisfy their target data-rates. In this module, it seeks to satisfy below conditions for all iϵ I.

$$\mu(t+1) = [\mu(t) + k(t)h(t)]_p \qquad (1)$$

Where t is the iteration step, h(t) is the sub gradient of objective function f(x) evaluated at point $\mu(t)$ and k(t). While the users in I are allocated a number for sub carriers by aggressive subcarrier reuse to reach their target data-rates, the algorithm proceeds to phase 2 where unused subcarriers are allocated to the users in J in the direct links to satisfy their target data-rates.

User selection

In this section, the base station is denoted as node 0 and defining the set J^+=J+{0}, let $\overline{h}_{iJ^+}$ denote the average channel gain from user i$\in I$ to the nodes in J^+ which is given by

$$\overline{h}_{iJ^+} = \frac{1}{|N||J^+|} \sum_{n \in N} \sum_{j \in J^+} h_{ij}^n \qquad (2)$$

The value of $\overline{h}_{iJ^+}$ is used as condition to discover the users in I that have a poor channel condition in the relay and direct links.

Algorithm 1

Phase 1 of the resource allocation algorithm in which subcarriers are aggressively reused in the relay links. The users in I are to be satisfied in this phase.

$I_u = I$

$N_{unused} = N$

$N_{reuse} = \emptyset$

$w_m^n = 0$, for every n ∈ N, for every m ∈ M

$\delta_m^n = 0$, for every n ∈ N, for every i∈I, for every j∈J

A = ∅

While $I_u \neq \emptyset$ do

$\overline{i} = argmin_{i \in I_u}(\overline{h}_{iJ^+} | i not\ belongs\ to\ A)$

A=A+{$\overline{i}$}

$\hat{n} = \emptyset$

$(\hat{n}, \hat{j})$= $argmax_{j \in j^+ (h_{ij}^n | R_j^r < T_j^r)}$

End if

If $\hat{j} = 0 \; then$

$w_i^{\hat{n}} = 1$

$N_{unused} = N_{unused} - \{\hat{n}\}$

Else

$\delta_{ij}^{\bar{n}} = 1$

$N_{unused} = N_{unused} - \{\hat{n}\}$

$N_{unused} = N_{unused} + \{\hat{n}\}$

End if

Uniform power allocation user $\hat{\imath}$

Calculate R_i

Refresh I_u

If $I_u \uparrow\subseteq A \; then$

A=∅

End if

End while

An unsatisfied user is selected from set I according to

$$\hat{i} = \arg\min_{i \in \mathcal{I}_u} \left(\overline{h}_{i\mathcal{J}+} \mid i \notin \mathcal{A} \right), \qquad (3)$$

Where Iu is the set of unsatisfied users in I and A is the set of users who have been assigned a subcarrier in the previous iterations. The reason for choosing the user with minimum $\overline{h}_{iJ^+}$ is that if the users with relatively larger $\overline{h}_{iJ^+}$ are selected first, users with small $\overline{h}_{iJ^+}$ may need several subcarriers until satisfaction because a potential good subcarrier may have been allocated to other users.

Link assignment

Once user $\hat{\imath}$ is determined according to (3), to benefit from intra-cell subcarrier reuse, it is first attempted to find a subcarrier for user $\hat{\imath}$ from the set of subcarriers that are already used in the relay links. A relay node must also be selected for user $\hat{\imath}$since intra-cell subcarrier reuse is only possible in the relay links. If a reusable subcarrier is not found due to excessive interference or lack of a suitable relay node for user $\hat{\imath}$, then an unused subcarrier will be allocated to user $\hat{\imath}$ in the relay or direct links.
The relay link with maximum channel gain for user $\hat{\imath}$ subject to four constraints:

1) The relay node $\hat{j}$ must only listen to user $\hat{\imath}$ on subcarrier $\hat{n}$ which is not used in the direct links.

2) The selected relay link must have a channel gain greater than a given threshold T^h

3) The intra-cell interference on subcarrier$\hat{n}$ at any node, must not exceed threshold T^{inth}

4) Relay node $\hat{j}$ must not have an aggregate relaying data-rate greater than threshold $T_{\hat{j}}^r$

Power assignment

The uniform power allocation for user $\hat{i}$ is given by

$$p_{\hat{i}}^{n^*} = \frac{P_{\hat{i}}^*}{\sum_{n\in\mathcal{N}} w_{\hat{i}}^n + \sum_{n\in\mathcal{N}}\sum_{j\in\mathcal{J}} \delta_{\hat{i}j}^n}, \quad (4)$$

Where n^* is any subcarrier allocated to user $\hat{i}$. When a subcarrier is allocated to user $\hat{i}$. in the relay or direct links, the corresponding power allocation is uniformly carried out. The power assignment is uniformly allocated as mentioned above.

1.4.3. SUBOPTIMAL RESOURCE ALLOCATION ALGORITHM WITH WATER FILLING METHOD FOR PHASE 2

In this module, the users in J are to be satisfied in phase 2. The users in J must achieve their own target data-rate plus the relaying data-rate imposed by the users in I. During each iteration in phase 2, an unsatisfied user is selected from J , a subcarrier is allocated to it in the direct links, and the corresponding transmit powers are set.

Algorithm 2

1: $\mathcal{J}_u = \mathcal{J}$
2: $\mathcal{A} = \emptyset$
3: **while** $\mathcal{J}_u \neq \emptyset$ **do**
4: $\quad \hat{j} = \arg\min_{j\in\mathcal{J}_u} \left(\sum_{n\in\mathcal{N}} h_j^n | j \notin \mathcal{A}\right)$
5: $\quad \mathcal{A} = \mathcal{A} + \{\hat{j}\}$
6: $\quad \hat{n} = \arg\max_{n\in\mathcal{N}_{unused}} \left(h_{\hat{j}}^n\right)$
7: $\quad w_{\hat{j}}^{\hat{n}} = 1$
8: $\quad \mathcal{N}_{unused} = \mathcal{N}_{unused} - \{\hat{n}\}$
9: $\quad$ water-filling power allocation for user $\hat{j}$
10: $\quad$ calculate $R_{\hat{j}}$
11: $\quad$ refresh $\mathcal{J}_u$
12: $\quad$ **if** $\mathcal{J}_u \subseteq \mathcal{A}$ **then**
13: $\quad\quad \mathcal{A} = \emptyset$
14: $\quad$ **end if**
15: **end while**

User selection

An unsatisfied user is selected from set J according to

$$\hat{j} = \arg\min_{j\in\mathcal{J}_u} \left(\overline{h}_j \,|\, j \notin \mathcal{A}\right), \quad (5)$$

Where J_u is the set of unsatisfied users in J and A is the set of users who have been assigned a subcarrier in the previous iterations. $\bar{h}_j$ is the average channel gain from user j to the base station. Similar to phase 1, the reason for choosing the user with minimum $\bar{h}_j$ is that if the users with relatively larger $\bar{h}_j$ are selected first, users with small $\bar{h}_j$ may need several subcarriers until satisfaction because a potential good subcarrier may have been allocated to other users.

Link assignment

Once user $\hat{j}$ is determined according to (5), a direct link must be selected for it. Searching only the unused subcarriers, a direct link which is identified by a subcarrier is assigned to user $\hat{\imath}$ according to

$$\hat{n} = \arg\max_{n \in \mathcal{N}_{unused}} \left(h_{\hat{j}}^{n}\right). \quad (6)$$

Therefore, an unused subcarrier with maximum channel gain is allocated to user $\hat{j}$ in the direct links.

Power assignment

When a subcarrier is allocated to user $\hat{j}$ in the direct links, to ensure maximum data-rate for a given subcarrier allocation, water-filling power allocation is carried out according to

$$p_{\hat{j}}^{n^*} = \max\left(\left(\lambda - \frac{\sigma^2}{h_{\hat{j}}^{n^*}}\right), 0\right), \quad (7)$$

Where n^* is any subcarrier assigned to user $\hat{j}$ and λ is a constant to satisfy power constraint for user $\hat{j}$.

1.4.4. EFFICIENT SUBOPTIMAL RESOURCE ALLOCATION ALGORITHM FOR PHASE 3

In this module, each iteration in phase 3, an unused subcarrier is selected and allocated to a user J such that the system sum rate is efficiently increased.

Algorithm 3

1. While $N_{unused} \neq \emptyset$ do
2. $\hat{n} = any\ subcarrier\ from\ N_{unused}$
3. $\hat{j} = argmax_{j \in J}\left(\nabla R_j^{\hat{n}}\right) | water\ filling\ allocation$
4. $w_j^{\hat{n}} = 1$
5. $N_{unused} = N_{unused} - \{\hat{n}\}$
6. $water\ filling\ power\ allocation\ for\ user\ \hat{j}$
7. $end\ while$

$$\hat{j} = argmax_{j \in J}\left(\nabla R_j^{\hat{n}}\right) | water\ filling\ allocation \quad (8)$$

Where $\nabla R_j^{\hat{n}}$ is the increase in data-rate of user $\hat{j}$ if subcarrier $\hat{n}$ is allocated to it. Water-filling power allocation given by (7) is carried out before calculating the increase in data rate. Equation (8) allocates an unused subcarrier to the user with the maximum data-rate increment, so the system sum-rate is increased in a most efficient way. This process continues until all of the remaining unused subcarriers are allocated.

1.4.5. DISCOVERY OF USER COOPERATION PATH

In this module, want to perform user cooperation path discovery more efficiently. If the resources are available then it is reallocated for high data rate users significantly. Any subcarrier is allowed to be reused in the relay links for the given scenario. Then have to select efficient and neighborhood user's cooperation path. The best channels are achieved by selecting the optimal links between. It is used to satisfy the large size of the data rate and huge number of users in the specified network by using available reusable resources.

1.4.6. IMPROVED SUBOPTIMAL RESOURCE ALLOCATION ALGORITHM (ISRAA OF AF)

In this module, apply the improved suboptimal resource allocation algorithm to increase the maximization of sum rate and reduction of power consumption.

Algorithm 4

1. Begin
2. Initialize I_{max} users, i=0, unused users, sum rate S_R and power consumption P_c
3. $\hat{n}$ = any subcarrier from N_{unused}
4. Calculate $\hat{k}(m,n) = \arg max_{s\in B_m} R_{m,s}$
5. Compute maximum sum rate and efficient power consumption using given below formula

$$S_R \,\&\, P_c = \frac{\sum_{m=1}^{M}\sum_{n=1}^{N} R_{m,k(m,n)}^{[n]}}{\sum_{m=1}^{M}\sum_{n=1}^{N}(\theta_m^{[n]}+p_m^{[n]})}$$

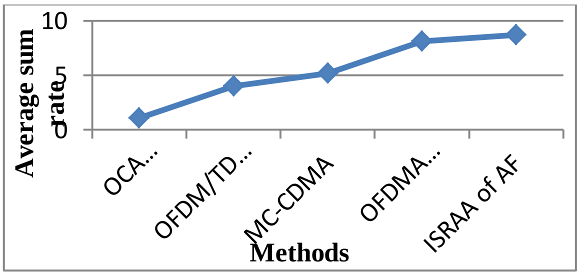
6. Update the power consumption value P_c
7. Update the maximum sum rate S_R
8. $\hat{n} = \arg\max(h_i^n + h_j^n)$
9. Select best reusable links
10. Stop

1.4.7. PERFORMANCE EVALUATION

In this section, performance metrics are compared by using resource allocation methods. The performance parameters are such as sum rate, power ratio, number of users, throughput, bandwidth and user satisfaction level which are evaluated by using the methodologies such as OCA method, OFDM/TDM, MC-CDMA, OFDMA with sub optimal method and amplify and forward method. The performance metrics are higher in the ISRAA of AF method rather than other methods.

AVERAGE SUM RATE

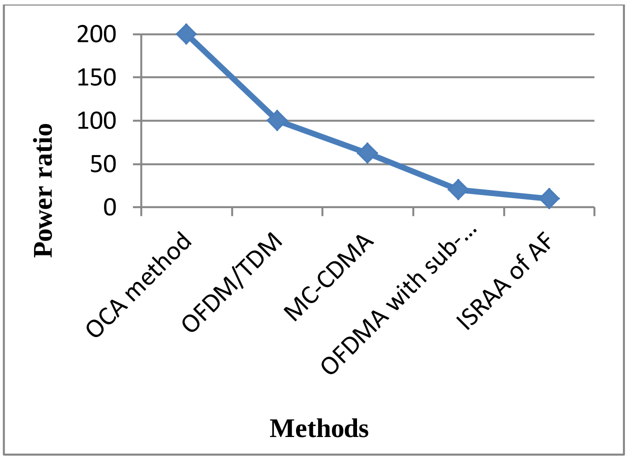
In network resource allocation process, the sum rate should be maximum. Then the system is used to provide sufficient services for available users.



From the above graph, can observe that the comparison graph is illustrated for the parameter average sum rate. In x-axis different methods are plotted and in y axis the average sum rate values are plotted . In the existing system, the average sum rate is lower by using OCA, OFDM/TDM, MC-CDMA method and OFDMA with sub optimal method. In proposed system, the average sum rate is increased by using ISRAA of AF algorithm significantly. Thus, the experimental result concludes that the ISRAA of AF algorithm is superior in resource reusable allocation process compare than other methods.

POWER RATIO

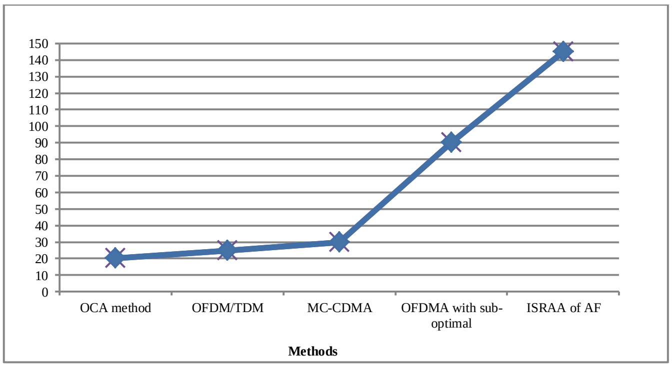
In networking process, the power consumption should be minimum and utilization of power should be efficiency. The sufficient power allocation has been performed in the network then it provides maximum utilization of resources for available users.



From the above graph, can observe that the comparison graph is illustrated for the parameter average sum rate. In x-axis the different methods are plotted and in y axis the power ratio values are plotted. In the existing system, the power consumption is high by using OCA, OFDM/TDM, MC-CDMA method and OFDMA with sub optimal method. In proposed system, the power consumption is reduced by using ISRAA of AF algorithm significantly. Thus, the experimental result concludes that the ISRAA of AF algorithm is superior in resource reusable allocation process compare than other methods.

NUMBER OF USERS

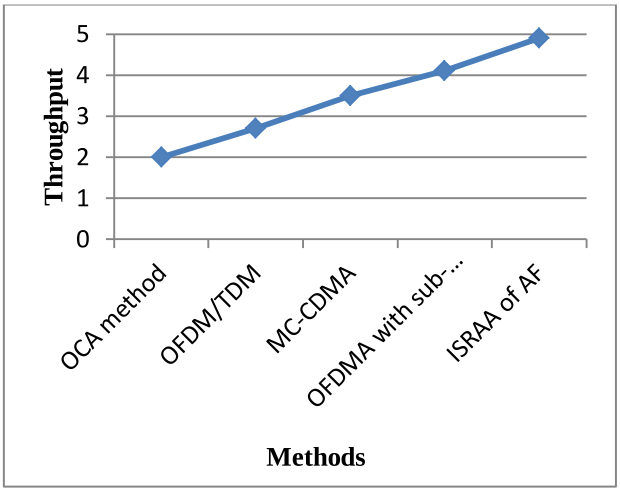
The system should achieve the largest capacity independently of the number of active users. For the available users, in the network, the methods guarantee for the optimal performance, network utility and capacity.



From the above graph, can observe that the comparison graph is illustrated for the parameter number of users. In x-axis the different methods are plotted and in y axis the numbers of users are plotted. In the existing system, the number of users is low due to insufficient resources by using OCA, OFDM/TDM, MC-CDMA method and OFDMA with sub optimal method. In proposed system, the numbers of users are increased through providing sufficient resources by using ISRAA of AF algorithm significantly. Thus, the experimental result concludes that the ISRAA of AF algorithm is superior in resource reusable allocation process compare than other methods.

THROUGHPUT

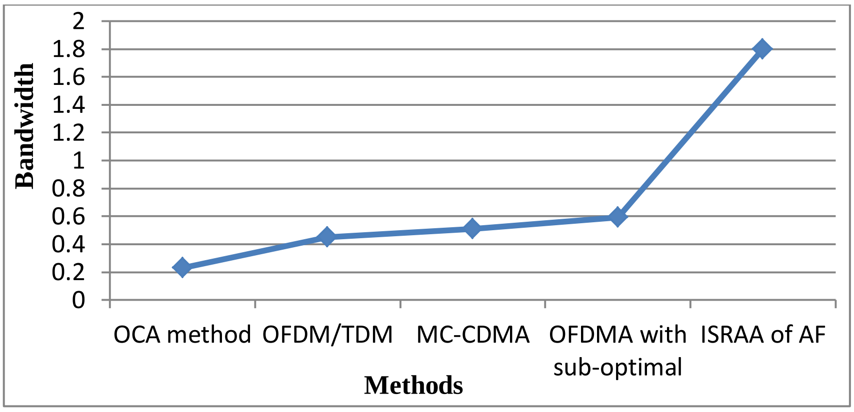
Usually the network is called better when the network achieved higher throughput. Throughput is measure of how many resources can process in a given amount of time for high rate of users.



From the above graph, can observe that the comparison graph is illustrated for the parameter throughput. In x-axis the different methods are plotted and in y axis the throughput is plotted. In the existing system, the throughput is low due to insufficient resources by using OCA, OFDM/TDM, MC-CDMA method and OFDMA with sub optimal method. In proposed system, the throughput is increased through providing sufficient resources by using ISRAA of AF algorithm significantly. Thus, the experimental result concludes that the ISRAA of AF algorithm is superior in resource reusable allocation process compare than other methods.

BANDWIDTH

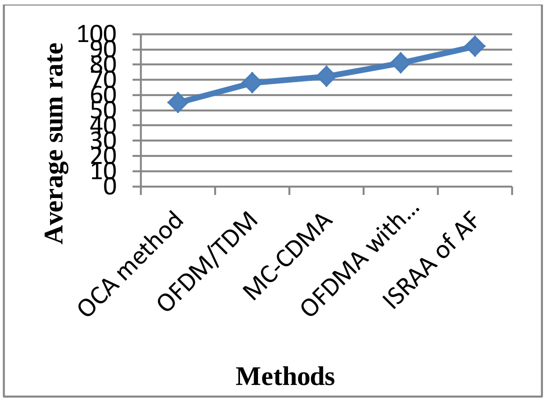
Bandwidth is defined as the amount of data is transmitted in a fixed amount of time within a band of frequencies.



From the above graph, can observe that the comparison graph is illustrated for the parameter bandwidth. In x-axis the different methods are plotted and in y axis the bandwidth is plotted. In the existing system, the bandwidth is low by using OCA, OFDM/TDM, MC-CDMA method and OFDMA with sub optimal method. In proposed system, the bandwidth is high by using ISRAA of AF algorithm significantly. Thus, the experimental result concludes that the ISRAA of AF algorithm is superior in resource reusable allocation process compare than other methods.

USER SATISFACTION LEVEL

If the user satisfaction level is high then the given network is superior. Each network should satisfy the users along with available resources, reusable resources and data rates, throughput, execution time.



From the above graph, can observe that the comparison graph is illustrated for the parameter user satisfaction level. In x-axis the different methods are plotted and in y axis the user satisfaction level is plotted. In the existing system, the user satisfaction level is low by using OCA, OFDM/TDM, MC-CDMA method and OFDMA with sub optimal method. In proposed system, the user satisfaction level is high by using ISRAA of AF algorithm significantly. Thus, the experimental result concludes that the ISRAA of AF algorithm is superior in resource reusable allocation process compare than other methods.

1.5 CONCLUSION AND FUTURE WORK

The improved resourced allocation method along with AF scheme can allocate the sufficient and efficient resources for distributed implementation. It is used to reduce the total power consumption than the existing scenario. It also improves the complexity reduction and increases the system efficiency significantly. The poor channel conditions are reduced significantly in the proposed system. From the experimental result, can conclude that the proposed sub optimal resource allocation algorithm is more efficient rather than other existing approaches in terms of higher sum rate, higher number of users and reduction in power consumption. For the future work, can analyze the performance of advanced techniques in the presence of imperfect channel state information at the base station. It will progress the higher data rates with maximum cooperative users by using reusable resources prominently in both distributed and dynamic environments.

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