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A user scheduler method in CoMP

Field of the invention

[0001] The present invention relates to a user scheduling method for improving the system capacity in wireless communication system, and more particularly, related to a CoMP(Coordinated Multi-Point) system which has a center processor.

Background

[0002] Future wireless communication system needs to support high speed and large capacity. However, the user terminal in cell edge will receive interference from other cells, which will cause the throughput of cell edge is smaller than that of the cell center.

[0003] CoMP(coordinated multi-point) is a coordinated technology which sharing channel and data information between several cells to prevent the interference from other cells. CoMP can improve the spectrum efficiency and system throughput. Each cell is placed with multiple antennas. MIMO takes advantage of multiplexing to increase wireless bandwidth and range. Several cells can schedule multiple users to communication simultaneously, further improving the system capacity. The interference between cells can be alleviated by carefully choosing users. User scheduler in CoMP is a key technology to increase the system capacity and cell edge user throughput.

[0004] CoMP includes two kinds of technologies, which are CS/CB(coordinated scheduling/coordinated beamforming) and JP(joint processing). For JP, there is a central processor which deals with data from several cells make a global scheduling.

[0005] For CS/CB, each cell makes a scheduling decision itself by considering reducing the interference from other cells. The invention mainly focuses on the JP method. In JP, as the total user number increases a lot as the central processor should consider the user from multiple cells, the user scheduling method complexity increases a lot. Therefore, a user scheduling method with

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low complexity is of great importance.

Summary of the invention

[0006] A user scheduler method in CoMP is disclosed in order to reduce the scheduler complexity and improve cell edge user performance.

[0007] User need to feedback channel information to base station for scheduling. The feedback information is a large overhead. Reducing the user candidate can reduce the complexity.

[0008] The main steps of a user scheduler method in CoMP are as follows:

(1) Each base station calculates the cell edge user group by calculating the SINR of users in the cell. The base station calculates the SINR of all the users in the cell and compare it to a threshold α. Suppose the SINR of ith user is $SINR_i$. If $SINR_i$ is lower than α, the ith user is put in the cell edge group set $\mathbf{A}_i$.suppose there are N cells, i=1,...,N.

(2) Base stations send the cell edge group set $\mathbf{A}_1, \mathbf{A}_2, \cdots, \mathbf{A}_N$ to the central scheduler. Central scheduler makes the total cell edge group $\Omega = \{\mathbf{A}_1 \cup \cdots \cup \mathbf{A}_N\}$.

(3) Users in group Ω calculate the channel estimation information and feedback the information to their corresponding base stations. Then these base stations send the information to the central scheduler.

(4) The central scheduler further reduces the cell edge group from Ω to $\tilde{\Omega}$ according the feedback information.

(5) The central scheduler chooses users set $\boldsymbol{S}$ from set $\tilde{\Omega}$ according to maximum capacity rule or weighted maximum capacity rule.

(6) The central scheduler design precoder based on the chosen user set **S**.

Brief description of the drawings

[0009] Fig.1 is a schematic diagram of the CoMP structure

[0010] Fig.2 is a schematic diagram of the user scheduler process

[0011] Fig.3 is schematic diagram of the user chosen process based on maximum capacity rule

Detailed description of the invention

[0012] This invention is further exemplified with the use of the figures and the embodiments. Certain embodiments of the invention may be found in a system for a user scheduler method in CoMP(coordinated multiple processing) downlink transmission. Various embodiments of the invention may reduce the computational complexity, at several base station comprising multiple antennas, associated with selecting a subset of mobile terminals which are to simultaneously receive a signal from multiple base station. The mobile terminals in the subset may be selected to maximize the system capacity or PF(proportional fair).

[0013] A communication from a base station to a mobile terminal, or user, may be referred to as a downlink communication. With multiple base station equipped with multiple antennas, these base station may select a group of the users to transmit their respective data streams simultaneously.

[0014] In a multiuser communication system, employing multiple antennas at several base stations may improve the cell edge spectrum efficiency. The capacity improvement may be attained by communicating simultaneously with multiple users by utilizing precoding at the transmitter when channel state information is available (CSI). A zero-forcing(ZF)linear precoder may achieve a sum capacity when the number of users,K, approaches infinity. When the user set is larger in multiple cell case ,i.e.K=10, ZF precoders may provide near-optimal performance even with a limited number of users. Therefore, precoding combined with user selection in a multiuser environment may represent a promising technique that may be utilized in broadband wireless data communication systems.

[0015] Fig.1 is a block diagram illustrating an exemplary multiple base stations in a multiuser environment. There are three cells **110**, **120**, **130** and three base stations **140**, **150**, **160**. When user terminals **170**, **180**, **190** are at cell edge, the signal they received may degrade a lot. In order

to improve cell edge performance, the three base stations may work together. However, as there are many users which are at cell edge, how to choose user correctly and efficiency is an important problem.

[0016] Fig.**2** is the main step of the invention. In step **210**, the base station **140, 150,160** calculate the cell edge user group respectively. Suppose the cell edge groups in cell **110, 120, 130** are $\mathbf{A}_1, \mathbf{A}_2, \mathbf{A}_3$. For example, The base station **140** calculate all the SINR of the users in the cell and compare it to a threshold α. Suppose the SINR of *i*th user is $SINR_i$. If $SINR_i$ is lower than α, the ith user is picked up in the cell edge group set $\mathbf{A}_1$.

[0017] In step **220**, the three base stations send the cell edge group set $\mathbf{A}_1, \mathbf{A}_2, \mathbf{A}_3$ to the central scheduler. Central scheduler makes the total cell edge group $\Omega = \{\mathbf{A}_1 \cup \mathbf{A}_2 \cup \mathbf{A}_3\}$

[0018] In step **230**, users in group Ω calculates the channel estimation information and feedback the information to the base stations. Then the base stations send the information to the central scheduler. The channel information includes channel vector $\mathbf{V}_i$ and channel quality q_i. Where *i* denotes the *i*th user.

[0019] The channel vector is obtained by performing SVD to the channel matrix.

$$\mathbf{H}_i = \mathbf{U}_i \Sigma_i \mathbf{V}_i$$

Where $\mathbf{V}_i$ is the channel vector. $\mathbf{H}_i$ is the channel matrix. q_i is the first diagonal value in Σ.

[0020] In step **240**, the central scheduler further reduces the cell edge group from Ω to $\tilde{\Omega}$ according the feedback information $\mathbf{V}_i$ and q_i. Suppose there are N users in set Ω. The steps are as follows:

a. Choosing the user K satisfying $k = \arg\max_{i=1,\cdots,N}(q_i)$

b. Calculating the channel correlation value

$$\alpha_i = \mathbf{V}_i^T \mathbf{V}_k \quad i = 1, \cdots, N \; i \neq k$$

c. Compare α_i with threshold β and choose user whose correlation value α_i is smaller than β

$$\tilde{\Omega} = \{user\ i \mid \alpha_i < \beta\}$$

[0021] In step **250**, the central scheduler chooses users set ***S*** from set $\tilde{\Omega}$ according to maximum capacity rule or weighted capacity rule.

[0022] The detailed steps are in Fig.**3**. In step **310**, the user with best channel quality is picked out first. In **320**, the maximum capacity is calculated according to the first user. The set **S** has one user now. The other users will be treated as candidate to calculate the sum capacity in company with the first user from step **330** to **350**. The system capacity will be compared to the maximum system capacity $C_{\max}$. When the system capacity determined in step **350** is higher than the current maximum system capacity, the process may proceed to step **360**. In step **360**, the maximum capacity $C_{\max}$ may be updated and the corresponding user set **S** may be updated either. In step **370**, the current user is compared to the total number of user set, N, to determine whether the search has reach the maximum user number. If the search has not been finished, the process may proceed to **330**.

[0023] In step **260**, since all the users have been picked up, the precoder can be designed by the central scheduler based on zero-forcing algorithm.

[0024] With the invention, the complexity of user chosen will be reduced a lot and cell edge user can achieve better performance in multi-cell environment.

Claim

1. A user scheduler method in CoMP(coordinated multi-point) system, comprising:

   Calculating cell edge user group $\mathbf{A}_i$ by *i*th base station according to user SNR;

   Sending cell edge user groups to central scheduler and deciding a total user set;

   Estimating and sending channel estimation to central scheduler;

   Reducing cell edge user candidate set based on channel estimation;

   Choosing users according to maximum capacity rule or weighted maximum capacity rule;

   Designing precoder based on chosen user set.

2. The method of claim 1 wherein Calculating cell edge user group $\mathbf{A}_i$ by *i*th base station comprises:

   Calculating user SNRs in the cell based on uplink reference signal;

   Comparing SINR to a threshold; If $SINR_i$ is lower than α, the ith user is chosen in the cell edge group set $\mathbf{A}_i$.

3. The method of claim 1 wherein deciding a total user set is based on the following rule:

$$\Omega = \{\mathbf{A}_1 \cup \cdots \cup \mathbf{A}_N\}$$

   Where Ω is the total cell edge group.

4. The method of claim 1 wherein the channel information includes channel vector $\mathbf{V}_i$ and channel quality q_i.

5. The method of claim 4 wherein $\mathbf{V}_i$ and channel quality q_i is obtained based on SVD of channel matrix.

6. The method of claim 1 wherein reducing cell edge user group Ω comprises:

   Choosing the user K satisfying:

$$k = \arg\max_{i=1,\cdots,N}(q_i)$$

   Calculating the channel correlation value based on the following formula:

$$\alpha_i = \mathbf{V}_i^T \mathbf{V}_k \quad i = 1,\cdots,N \; i \neq k$$

Comparing α_i with threshold β and choosing user whose correlation value α_i is smaller than β.