



A Multicast Beamforming Algorithm to Improve the Performance of Group Service for Multicell B-TrunC System

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Abstract. With the increasing demand for the command and dispatch service of private network communication system, broadband trunking communication (B-TrunC) system and its standards are improving steadily. In order to improve the performance of group service of B-TrunC system, we propose a system model with same-frequency multicell coordination for group users and a multicast beamforming algorithm based on the system model. The proposed system model combines multicell coordination and same-frequency scheduling. The multicast beamforming optimization problem is a non-deterministic polynomial hard (NP-hard) problem. The mathematical model of the proposed algorithm is obtained according to direction of departure (DOD) of group users and max-min fairness (MMF) principle; the optimal approximate solution of transmitting multicast beamforming weight vector, which maximizes the least received SNR of group users, is obtained on the basis of semidefinite relaxation (SDR). Theoretical analysis and simulation results show that the proposed multicast beamforming algorithm based on same-frequency multicell coordination can significantly improve the SNR of cell-edge users and increase the group user channel capacity. As the group user angle interval decreases or the base station antenna number increases, the performance of the proposed algorithm is further improved.

Keywords: B-TrunC system · Multicast beamforming ·
Multicell coordination · Same-frequency scheduling · Group service

1 Introduction

As an important part of wireless communication, private network communication system with the core business of public service and public safety is developing rapidly around the world. Industry users urgently need private network to provide broadband

This paper is sponsored by the National Natural Science Foundation of China (No. 61771169 and 61831002), the funds of Science and Technology on Communication Networks Laboratory (No. XX17641X011-04) and the Postdoctoral Science-Research Foundation of Heilongjiang (Grant No. LBH-Q11108).

services such as high-speed data, images and video. The broadbandization of private network communication system is imperative and urgent. The researches on B-TrunC system, which is based on 4G core technology, have received extensive attention in recent years [1]. Group service is the core business of B-TrunC system. The improvement of the performance of group service has important theoretical significance and application value for promoting the development of B-TrunC system.

Nowadays, the group service of the B-TrunC system adopts inter-frequency scheduling method in different base stations. The same frequencies will be distributed to the same group users in same base station but the different frequencies will be distributed to the same group users in different base stations. This method has shortcomings in group user handover delay, cell-edge user performance, and group user channel capacity, etc. Thus, in this paper, a system model with same-frequency multicell coordination for group users and a multicast beamforming algorithm combined multicell coordination and same-frequency scheduling is studied to improve the performance of group service of B-TrunC system.

Beamforming technology can make full use of the spatial domain resources and improve the energy efficiency of wireless communication system [2, 3]. A lot of research results have been achieved on point-to-point single-user beamforming [4]. The research on multicast beamforming for group users has received increasing attention with the increasing demand for multicast services [5, 6]. The difficulty of multicast beamforming for group users is that no matter which beamforming principle is adopted, the optimization of beamforming weight vector is a non-deterministic polynomial hard (NP-hard) problem [7]. The optimal solution can be obtained by sequential quadratic programming (SQP) but with high computational complexity [8]. The semi-definite relaxation (SDR) algorithm can reduce the computational complexity with little performance loss. Reference [9] proposes a multicast beamforming algorithm based on unicast, which improves the performance of zero-forcing method and minimum mean square error method. In [10], the problem of multicast beamforming with perfect and imperfect channel status information (CSI) is studied based on an iterative approach. However, the above studies on beamforming only consider the case of group users in a single base station without considering in multiple base stations scenarios.

The performance for cell-edge users in the group service of B-TrunC system directly affects the overall performance. Multicell coordination can improve the performance for cell-edge users, and further improve the overall performance for group users. In [11], a multi-point coordination scheduling method is adopted to reduce the interference between users in different base stations and improve the performance for cell-edge users. However, the spatial domain resources are not fully utilized, since it uses frequency division multiplexing for the same group users of different base stations.

In order to improve the performance of group service of B-TrunC system, a system model with same-frequency multicell coordination for group users is studied and a multicast beamforming algorithm combined multicell coordination and same-frequency scheduling for B-TrunC system is proposed. The multicast beamforming algorithm based on max-min fairness (MMF) principle fully utilizes the spatial domain resources. The optimal solution of the algorithm is a NP-hard problem and the optimal approximate solution is obtained by semidefinite relaxation.

2 System Model and Optimization Problem

In order to evaluate the performance of the proposed system model and the multicast beamforming algorithm, the system model of the proposed same-frequency multicell coordination (SFMC) is shown in Fig. 1(a); the system model of the original private network non-cooperation (OPNN) is shown in Fig. 1(b); the system model of the original multimedia broadcast/multicast service single frequency network (OMBSFN) with omnidirectional antenna is shown in Fig. 1(c).

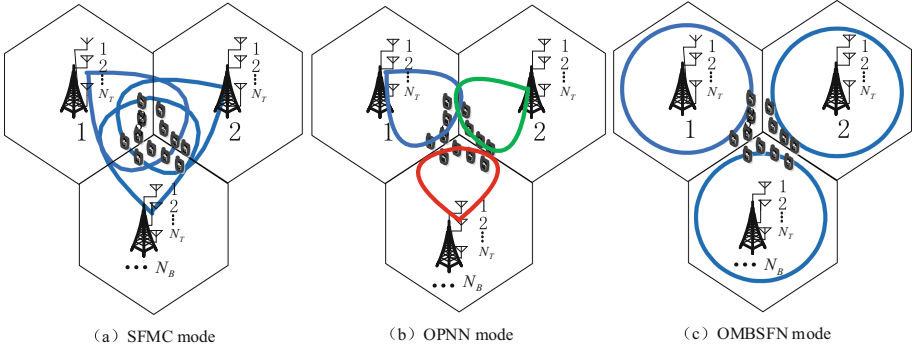


Fig. 1. System model of three modes

As is shown in Fig. 1(a), there are N_B base stations. Each base station adopts uniform linear array with N_T array elements. And there are M single-antenna users per base station, and all belong to the same group. According to the characteristics that the group users of private network are concentrated and the angle information is easily obtained, the channel model adopts the direction of departure (DOD) mode in this paper. The downlink between the i -th base station and the k -th user in the j -th base station can be expressed as

$$\begin{aligned} \mathbf{h}_{i, \langle j, k \rangle} &= \mathbf{a}_{i, \langle j, k \rangle} \mathbf{g}_{i, \langle j, k \rangle} \\ &= [h_1^{i, \langle j, k \rangle} \quad h_2^{i, \langle j, k \rangle} \quad \dots \quad h_{N_T}^{i, \langle j, k \rangle}]^T \end{aligned} \quad (1)$$

Where $\mathbf{a}_{i, \langle j, k \rangle}$ is a $N_T \times d_k$ dimensional steering matrix; $\mathbf{g}_{i, \langle j, k \rangle}$ is a $d_k \times 1$ dimensional independent identically distributed complex Gaussian matrix with zero-mean unit-variance per element; d_k is the corresponding DOD multipath number of emission array. In uniform linear array, it can be expressed as:

$$\mathbf{a}_{i, \langle j, k \rangle} = \frac{1}{\sqrt{d_k}} \times [\mathbf{a}(\theta_1^{i, \langle j, k \rangle}), \dots, \mathbf{a}(\theta_{d_k}^{i, \langle j, k \rangle})] \quad (2)$$

$$\mathbf{a}(\theta) = [1, e^{j2\pi \frac{d \sin \theta}{\lambda}}, \dots, e^{j2\pi (N_T-1) \frac{d \sin \theta}{\lambda}}]^T \quad (3)$$

Where d is the antenna array element interval; λ is the wavelength of carrier; θ is the DOD. Suppose $\hat{\theta}_{i,<j,k>}$ is the DOD central angle between the i -th base station and the k -th user in the j -th base station, angle expansion is $\Delta\psi_k$, then we have $\theta_{d_k}^{i,<j,k>} = \hat{\theta}_{i,<j,k>} + \rho\Delta\psi_k$, $\rho \in [-1, 1]$.

The transmitting beamforming weight vector of the i -th base station is $\mathbf{w}_i = [w_1 w_2 \cdots w_{N_T}]^T$ which is a N_T -dimensional column vector; s is the transmitting signal; n is Gaussian noise. Then the received signal of the k -th user in the j -th base station can be expressed as

$$\begin{aligned} r_{<j,k>} &= \sum_{i=1}^{N_B} \mathbf{h}_{i,<j,k>}^H \mathbf{w}_i s + n \\ &= \mathbf{h}_{j,<j,k>}^H \mathbf{w}_j s + \sum_{i=1, i \neq j}^{N_B} \mathbf{h}_{i,<j,k>}^H \mathbf{w}_i s + n \end{aligned} \tag{4}$$

In (4), the received signals of the user consist of two parts, one is from the base station which is the user located and the other is from other base stations. In this system model, different base stations use the same time-frequency resources to transmit the same group service information. Cell-edge user can receive signals sent by multiple base stations simultaneously. The SNR of all the received signals of the user can be expressed as

$$\begin{aligned} SNR_{SFMC<j,k>} &= \sum_{i=1}^{N_B} |\mathbf{w}_i^H \mathbf{h}_{i,<j,k>}|^2 \\ &= |\mathbf{w}_j^H \mathbf{h}_{j,<j,k>}|^2 + \sum_{i=1, i \neq j}^{N_B} |\mathbf{w}_i^H \mathbf{h}_{i,<j,k>}|^2 \end{aligned} \tag{5}$$

In private network communication system, the performance of group service must be guaranteed for all users in the same group. In order to ensure the performance of the group user with the worst received signal, the max-min fairness (MMF) beamforming principle is adopted, which is to maximize the least SNR of the users in the group. Constrain the transmitting power of each base station to be P , then the mathematical model for the multicast beamforming optimization problem with same-frequency multicell coordination is derived as

$$\begin{aligned} \max_{w_1 \cdots w_{N_B}} \quad & \min_{<j,k>} \left(\sum_{i=1}^{N_B} |\mathbf{w}_i^H \mathbf{h}_{i,<j,k>}|^2 \right) \\ \text{s.t.} \quad & j \in \{1, \cdots, N_B\}, k \in \{1, \cdots, M\} \\ & \mathbf{w}_i^H \mathbf{w}_i = P \quad \forall i = 1, \cdots, N_B \end{aligned} \tag{6}$$

From (6), this optimization problem is a NP-hard problem and cannot be solved directly. In this paper, a multicast beamforming algorithm based on semi-definite relaxation is proposed. The algorithm description will be given in the next section.

From Fig. 1(b), in the original private network, the same group users located in different base stations are assigned different subcarriers, and the user only receive signals sent by its own base station. The received SNR of the k -th user in the j -th base station is expressed as

$$SNR_{OPNN \langle j,k \rangle} = \left| \mathbf{w}_j^H \mathbf{h}_{j, \langle j,k \rangle} \right|^2 \quad (7)$$

As is shown in Fig. 1(c), the original MBSFN mode with omnidirectional antenna doesn't adopt beamforming technology. The received SNR of the k -th user in the j -th base station is expressed as

$$SNR_{OPNN \langle j,k \rangle} = \sum_{i=1}^{N_B} \left| \mathbf{w}_0 \mathbf{h}_{i, \langle j,k \rangle} \right|^2 = \left| \mathbf{w}_0 \mathbf{h}_{j, \langle j,k \rangle} \right|^2 + \sum_{i=1, i \neq j}^{N_B} \left| \mathbf{w}_0 \mathbf{h}_{i, \langle j,k \rangle} \right|^2 \quad (8)$$

Where $\mathbf{w}_0 = \sqrt{P/N_T} \cdot \mathbf{I}_{N_T}$, the power is evenly distributed among the N_T antennas, and the signal propagates evenly in each direction. Power is wasted since the CSI is not utilized.

By comparing (5) (7) (8), it can be inferred that SNR_{SFMC} is greater than SNR_{OPNN} and SNR_{OMBSFN} under the same base station transmitting power.

The group user channel capacity is defined as the average channel capacity of all the group users. Since the same group users receive the same information, the group user channel capacity in the three modes is defined as follows:

The proposed same-frequency multicell coordination (SFMC) mode:

$$C_{SFMC} = \frac{1}{N_B \times M} \sum_{j=1}^{N_B} \sum_{k=1}^M \log_2 \left(1 + \left| \mathbf{w}_j^H \mathbf{h}_{j, \langle j,k \rangle} \right|^2 + \sum_{i=1, i \neq j}^{N_B} \left| \mathbf{w}_i^H \mathbf{h}_{i, \langle j,k \rangle} \right|^2 \right) \quad (9)$$

The original private network non-cooperation (OPNN) mode:

$$C_{OPNN} = \frac{1}{N_B \times M} \sum_{j=1}^{N_B} \sum_{k=1}^M \log_2 \left(1 + \left| \mathbf{w}_j^H \mathbf{h}_{j, \langle j,k \rangle} \right|^2 \right) \quad (10)$$

The original MBSFN (OMBSFN) with omnidirectional antenna mode:

$$C_{OMBSFN} = \frac{1}{N_B \times M} \sum_{j=1}^{N_B} \sum_{k=1}^M \log_2 \left(1 + \left| \mathbf{w}_0 \mathbf{h}_{j, \langle j,k \rangle} \right|^2 + \sum_{i=1, i \neq j}^{N_B} \left| \mathbf{w}_0 \mathbf{h}_{i, \langle j,k \rangle} \right|^2 \right) \quad (11)$$

By comparing (9) (10) (11), it can be inferred that the proposed SFMC mode has a larger group user channel capacity than the other two modes under the same base

station transmitting power. This is because the group user in SFMC mode can receive the signals from multiple base stations by multicast beamforming.

3 Multicast Beamforming Algorithm Based on SDR

In order to obtain the optimal approximate solution of the NP-hard problem, a same-frequency multicell coordination multicast beamforming algorithm based on semidefinite relaxation is proposed. Specific steps of the algorithm are as follows:

(1) Transforming the mathematical models

Suppose $\mathbf{W}_i = \mathbf{w}_i \mathbf{w}_i^H$, $\mathbf{H}_{i, \langle j,k \rangle} = \mathbf{h}_{i, \langle j,k \rangle} \mathbf{h}_{i, \langle j,k \rangle}^H$, then by the property of matrix we can derived that

$$\begin{aligned} |\mathbf{w}_i^H \mathbf{h}_{i, \langle j,k \rangle}|^2 &= \mathbf{w}_i^H \mathbf{h}_{i, \langle j,k \rangle} \mathbf{h}_{i, \langle j,k \rangle}^H \mathbf{w}_i = \text{tr}(\mathbf{w}_i \mathbf{w}_i^H \mathbf{h}_{i, \langle j,k \rangle} \mathbf{h}_{i, \langle j,k \rangle}^H) \\ &= \text{tr}(\mathbf{W}_i \mathbf{H}_{i, \langle j,k \rangle}) = \text{vec}(\mathbf{H}_{i, \langle j,k \rangle}^T)^T \text{vec}(\mathbf{W}_i) \end{aligned} \tag{12}$$

$$\mathbf{w}_i \mathbf{w}_i^H = \text{tr}(\mathbf{W}_i) = \text{vec}(\mathbf{I}_N)^T \text{vec}(\mathbf{W}_i) \tag{13}$$

Where $\text{vec}(\cdot)$ means vectorized representation of matrix columns. Substituting (12) (13) into (6), the optimization problem of (6) is transformed into:

$$\begin{aligned} \max \quad & \min_{\langle j,k \rangle} \left\{ \sum_{i=1}^{N_B} \text{tr}(\mathbf{W}_i \mathbf{H}_{i, \langle j,k \rangle}) \right\} \quad j \in \{1, \dots, N_B\}, k \in \{1, \dots, M\} \\ \text{s.t.} \quad & \text{tr}(\mathbf{W}_i) = P, \text{rank}(\mathbf{W}_i) = 1, \mathbf{W}_i \geq 0, \quad \forall i = 1, \dots, N_B \end{aligned} \tag{14}$$

Where $\mathbf{W}_i \geq 0$ means that the matrix \mathbf{W}_i is a semi-definite matrix.

(2) Relax the restrictions and turn the problem into a typical SDP problem

Compared with the standard form of SDP problem, the mathematical model in (14) only adds the restriction that $\text{rank}(\mathbf{W}_i) = 1$. We ignore this restriction first and (14) is re-written as

$$\begin{aligned} \max \quad & \min_{\langle j,k \rangle} \left\{ \sum_{i=1}^{N_B} \text{tr}(\mathbf{W}_i \mathbf{H}_{i, \langle j,k \rangle}) \right\} \quad j \in \{1, \dots, N_B\}, k \in \{1, \dots, M\} \\ \text{s.t.} \quad & \text{tr}(\mathbf{W}_i) = P, \quad \mathbf{W}_i \geq 0, \quad \forall i = 1, \dots, N_B \end{aligned} \tag{15}$$

At this point, the optimization problem has been transformed into a SDP problem. For the convenience of solving, we suppose $t = \min_{\langle j,k \rangle} \left\{ \sum_{i=1}^{N_B} \text{tr}(\mathbf{W}_i \mathbf{H}_{i, \langle j,k \rangle}) \right\}$, and substitute it into (15), then (15) is re-written as

$$\begin{aligned}
& \max && t \\
& s.t. && \sum_{i=1}^{N_B} \text{tr}(\mathbf{W}_i \mathbf{H}_{i, \langle j, k \rangle}) \geq t, \quad \forall j = 1, \dots, N_B, \quad \forall k = 1, \dots, M \\
& && \text{tr}(\mathbf{W}_i) = P, \mathbf{W}_i \geq 0, \quad \forall i = 1, \dots, N_B \\
& && t \geq 0
\end{aligned} \tag{16}$$

In order to transform the inequations into equations, we introduce a free variable $s_{\langle j, k \rangle}$, and substitute (12) (13) into (16), then we have

$$\begin{aligned}
& \min && -t \\
& s.t. && -t - s_{\langle j, k \rangle} + \sum_{i=1}^{N_B} \text{vec}(\mathbf{H}_{i, \langle j, k \rangle}^T)^T \text{vec}(\mathbf{W}_i) = 0, \quad \forall j = 1, \dots, N_B, \quad \forall k = 1, \dots, M \\
& && \text{vec}(\mathbf{I}_N)^T \text{vec}(\mathbf{W}_i) = P, \mathbf{W}_i \geq 0, \quad \forall i = 1, \dots, N_B \\
& && t \geq 0, s_{\langle j, k \rangle} \geq 0, \quad \forall j = 1, \dots, N_B, \quad \forall k = 1, \dots, M
\end{aligned} \tag{17}$$

(3) Optimization tool

We use SeDuMi to get \mathbf{W}_i . SeDuMi is an optimization tool to solve the SDP problem.

The dual format of SDP is given as:

$$\begin{aligned}
& \min && \mathbf{c}^T \mathbf{x} \\
& s.t. && \mathbf{A}_{eq} \mathbf{x} = \mathbf{b}_{eq} \\
& && \mathbf{A}_q \mathbf{x} = \mathbf{b}_q \\
& && \mathbf{F}(\mathbf{x}) = \mathbf{F}_0 + \sum_{i=1}^n x_i \mathbf{F}_i \geq 0
\end{aligned} \tag{18}$$

Let $\mathbf{x} = [t, s_{\langle 1, 1 \rangle}, s_{\langle 1, 2 \rangle}, \dots, s_{\langle N_B, M \rangle}, \text{vec}(\mathbf{W}_1), \text{vec}(\mathbf{W}_2), \dots, \text{vec}(\mathbf{W}_{N_B})]$.

Compare the coefficient of the relaxed model in (17) with the dual format of SDP in (18), and then we can obtain:

$$\mathbf{c}^T = [-1, \text{zeros}(1, M \times N_B + N_B^2 \times N_B)] \tag{19}$$

$$\mathbf{b}_q = [\text{zeros}(1, M \times N_B), P \times \text{ones}(1, N_B)]^T \tag{20}$$

$$\mathbf{A}_q = \begin{bmatrix} \mathbf{A}_1 & \mathbf{A}_2 \\ \mathbf{A}_3 & \mathbf{A}_4 \end{bmatrix} \tag{21}$$

Where:

$$\mathbf{A}_1 = \begin{bmatrix} -1 & -1 & 0 & \cdots & 0 \\ -1 & 0 & -1 & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ -1 & 0 & 0 & \cdots & -1 \end{bmatrix} \quad (22)$$

$$\mathbf{A}_2 = \begin{bmatrix} \text{vec}(\mathbf{H}_{1,<1,1>}^T)^T & \text{vec}(\mathbf{H}_{2,<1,1>}^T)^T & \cdots & \text{vec}(\mathbf{H}_{N_B,<1,1>}^T)^T \\ \text{vec}(\mathbf{H}_{1,<1,2>}^T)^T & \text{vec}(\mathbf{H}_{2,<1,2>}^T)^T & \cdots & \text{vec}(\mathbf{H}_{N_B,<1,2>}^T)^T \\ \vdots & \vdots & \ddots & \vdots \\ \text{vec}(\mathbf{H}_{1,<N_B,M>}^T)^T & \text{vec}(\mathbf{H}_{2,<N_B,M>}^T)^T & \cdots & \text{vec}(\mathbf{H}_{N_B,<N_B,M>}^T)^T \end{bmatrix} \quad (23)$$

$$\mathbf{A}_3 = \text{zeros}[N_B, M \times N_B + 1] \quad (24)$$

$$\mathbf{A}_4 = \begin{bmatrix} \text{vec}(I_{N_T})^T & 0 & \cdots & 0 \\ 0 & \text{vec}(I_{N_T})^T & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \text{vec}(I_{N_T})^T \end{bmatrix} \quad (25)$$

$$K.l = (M + 1) \times N_B \quad (26)$$

$$K.s = N_T \quad (27)$$

Where, the dimension of \mathbf{A}_1 is $(M \times N_B) \times (M \times N_B + 1)$; the dimension of \mathbf{A}_2 is $(M \times N_B) \times (N_B \times N_T^2)$; the dimension of \mathbf{A}_3 is $N_B \times (M \times N_B + 1)$; the dimension of \mathbf{A}_4 is $N_B \times (N_B \times N_T^2)$; $K.l$ represents the number of equality constraints; $K.s$ represents the order of LMI (Linear Matrix Inequality). Substitute the above parameters into the optimization tool, SeDuMi function, and the optimal solution \mathbf{x} is obtained, and then we choose the $s + 2 + (i - 1) \times N_T^2$ column to the $s + 1 + i \times N_T^2$ column of \mathbf{x} as $\text{vec}(\mathbf{W}_i)$. Then, we can obtain the matrix \mathbf{W}_i by converting $\text{vec}(\mathbf{W}_i)$.

(4) Randomization and choosing the relatively optimal solution

Due to the condition that $\text{rank}(\mathbf{W}_i) = 1$ was ignored in (15), the \mathbf{W}_i we obtained may not meet the restriction $\text{rank}(\mathbf{W}_i) = 1$. If the rank of the obtained \mathbf{W}_i is 1, we decompose \mathbf{W}_i according to the form $\mathbf{W}_i = \mathbf{w}_i \mathbf{w}_i^H$, then \mathbf{w}_i is the exact solution. If the rank of the obtained \mathbf{W}_i is not 1, we need to use the randomizing method to get the optimal approximate solution that satisfies $\text{rank}(\mathbf{W}_i) = 1$. The randomizing method we used in this paper is as follows:

We decompose each matrix \mathbf{W}_i ($\forall i = 1, \dots, N_B$) and get $\mathbf{W}_i = \mathbf{U}_i \Sigma_i \mathbf{U}_i^H$; \mathbf{U}_i and Σ_i are corresponding eigenvector and eigenvalue matrix. Let $\mathbf{w}_i = \mathbf{U}_i \Sigma_i^{1/2} \mathbf{e}_i$, where $\mathbf{e}_i \in C^{N_T \times 1}$, its q -th element $[\mathbf{e}_i]_q = e^{j\theta_{i,q}}$ is a random variable uniformly distributed on the unit circle, which means $\theta_{i,q}$ is a random variable that is evenly distributed within $[0, 2\pi)$.

A set of candidates of transmitting multicast beamforming weight vector \mathbf{w}_i are obtained by the method above. And then these vectors are scaled up to reach $\|\mathbf{w}_i\|_2^2 = P$,

which is the constraint of the base station transmitting power. The transmitting multicast beamforming weight vector with the max least SNR selected from these candidate vectors is used as the optimal approximate solution.

4 Simulation Analysis

The simulation parameters of the proposed SFMC mode, the OPNN mode and the OMBSFN mode (omnidirectional antenna) are shown in Table 1.

Table 1. Simulation parameters

Parameters	Value
Number of base stations (N_B)	3
Number of single base station antennas (N_T)	4
Number of single base station users (M)	5
Group user angle interval	2°

The comparison of the least received SNR and the group user channel capacity in the three modes are shown in Figs. 2 and 3 respectively. Figure 2 shows that under the same transmitting power of base station, the least received SNR of group users in the proposed SFMC mode is 4 dB and 2 dB higher than that of OPNN mode and OMBSFN mode. Figure 3 shows that compared with OPNN mode and OMBSFN mode, the group user channel capacity in the proposed SFMC mode is significantly improved. This is because the SFMC mode adopts the proposed multicast beamforming algorithm, the spatial domain resources are fully utilized and the cell-edge users can receive the same information from multiple base stations.

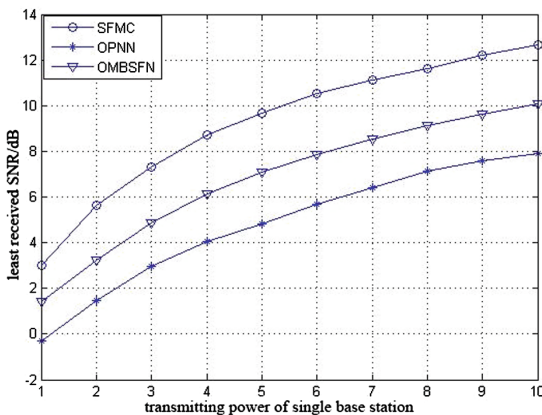


Fig. 2. Least received SNR of group users in the three modes

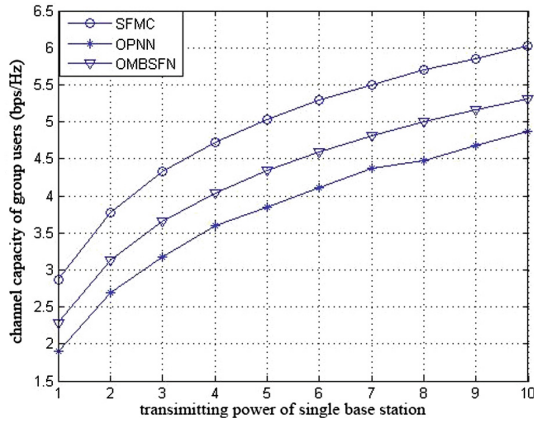


Fig. 3. Group user channel capacity in the three modes

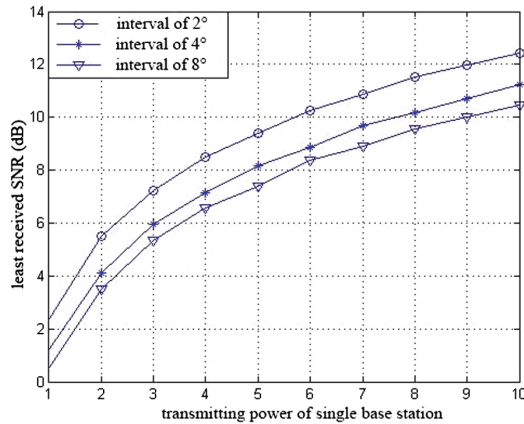


Fig. 4. The performance of the proposed algorithm and the group user angle interval

The relationships between the group user angle interval, the base station antenna number and the performance of the proposed SFMC algorithm are shown in Figs. 4 and 5 respectively. As is shown in Fig. 4, the smaller the group user angle interval is, the better performance the proposed algorithm has. Because the group user angle interval is smaller, the beam lobes are more concentrated by using the multicast beamforming algorithm based on DOD. Thus, the energy will be more concentrated, which leads to the larger the received SNR of the group users. From Fig. 5, the larger the base station antenna number is, the better performance the proposed algorithm has. When the base station antenna number increases from 2 to 4, the SNR is significantly improved. When the base station antenna number increases from 4 to 8, the SNR increases slowly. Therefore, the proposed algorithm can achieve great performance improvement without requiring too many transmitting antennas.

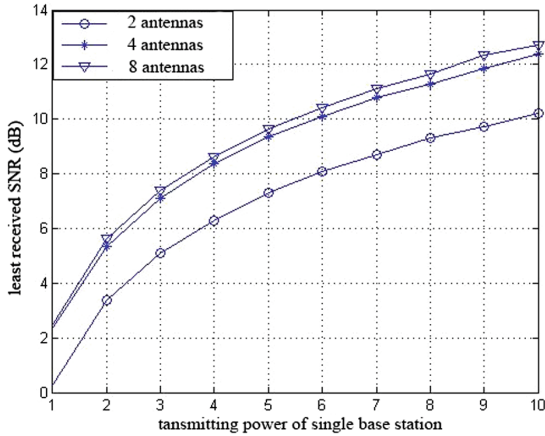


Fig. 5. The performance of the proposed algorithm and the base station antenna number

5 Conclusion

In order to improve the performance of group service of B-TrunC system, a system model of same-frequency multicell coordination mode and a multicast beamforming algorithm are proposed based on the characteristics of group user concentrated distribution and the angle information easy to get. Compared with the inter-frequency non-coordination mode and single frequency network mode with omnidirectional antenna, the proposed algorithm can improve the performance for the cell-edge users and increase the group user channel capacity. And the performance of the algorithm will be further improved as the group user angle interval decreases or the base station antenna number increases.

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