Relay Selection for Grouped-Relay Networks Using the Average SLNR Measure

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***Abstract*—In this paper, a distributed grouped-relay network with multiple source and destination nodes is introduced, and its distributed beamforming based on an average signal-to-leakage-plus-noise ratio (SLNR) is proposed to mitigate interference and colored noise from the multiple relay groups. Through system bit-error-rate simulations, it is verified that the performance of the leakage-based selection scheme is comparable to a signal-to-interference-plus-noise ratio (SINR)-based optimal beamforming method albeit at much lower complexity.**

***Index Terms*—Signal-to-leakage-plus-noise ratio (SLNR), beamforming, relay selection, multiuser communications.**

I. Introduction

In distributed relay networks, signal-to-interference-plus-noise ratio (SINR) and the mean-square-error (MSE) criterion have been used to measure and improve system performance [1], [2]. However, due to the coupled nature of the variables in the resulting optimization problems, no closed formed solutions are generally available. In [3], grouped-relay networks were proposed and their relay processing weights were instead designed by using a signal-to-leakage-plus-noise ratio (SLNR) criterion [4], [5], which leads to a decoupled optimization problem.

In this paper, grouped-relay networks of [3] are revisited (see Fig. 1), and their relay beamforming weights are designed based on an *average* SLNR criterion. As a result, the relay beamforming design does not require full channel information and it degenerates to selecting the relay that yields the maximum average SLNR. A comparison of the system bit-error-rate (BER) of the proposed SLNR-based selection and other methods, such as random selection, SINR-based selection, and SINR-based optimal beamforming methods, is performed numerically by computer simulation to verify the reliability of the proposed method.

Notation. Throughout this paper, for any vector or matrix, the superscripts 'T' and '$*$' denote transposition and complex conjugate transposition, respectively. For any scalar q and vector $\boldsymbol{q}$, the notation $|q|$ and $\|\boldsymbol{q}\|$ denote the absolute value of q and the 2-norm of $\boldsymbol{q}$, respectively; $\boldsymbol{I}_q$ is a q-dimensional identity matrix; $\boldsymbol{q}^{(n)}$ is the nth element of the vector $\boldsymbol{q}$; $\mathrm{diag}(\boldsymbol{Q})$ is a column vector containing the diagonal entries of the square matrix $\boldsymbol{Q}$; $\mathrm{diag}(\boldsymbol{q})$ denotes a diagonal matrix with the elements of the vector $\boldsymbol{q}$ as its diagonal entries; and 'E' stands for the expectation of a random variable.

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II. System and Signal Models

A two-hop grouped-relay network [3] is shown in Fig. 1. There are K sources $\{\mathrm{S}_1, \mathrm{S}_2 \ldots, \mathrm{S}_K\}$, K relay groups $\{1, 2, \ldots, K\}$, and K destinations $\{\mathrm{D}_1, \mathrm{D}_2, \ldots, \mathrm{D}_K\}$. Each node has a single antenna. The ith source S_i transmits data to the ith destination D_i by using the ith group consisting of N_i relays. The first-hop channel from the ith source to the nth relay in the jth relay group is represented by $f_{j,i}^{(n)}$. The second-hop channel from the nth relay in the ith relay group to the jth destination is represented by $g_{j,i}^{(n)}$. The channels $f_{j,i}^{(n)}$ and $g_{j,i}^{(n)}$ are i.i.d and zero-mean complex Gaussian random variables with variances $\sigma_{f,j,i}^{2(n)}$ and $\sigma_{g,j,i}^{2(n)}$, respectively. The data symbol of S_i at time t is denoted by $d_i(t)$ with $\mathrm{E}\,|d_i(t)|^2 = 1$. In the first phase, the K sources transmit their data simultaneously to the relay groups. Through the first-hop, the received signal vector $\boldsymbol{r}_k(t) \in \mathbb{C}^{N_k \times 1}$ at the kth relay group is

$$\boldsymbol{r}_k(t) = \sum_{j=1}^{K} \boldsymbol{f}_{k,j} d_j(t) + \boldsymbol{n}_{r,k}(t) \tag{1}$$

where $\boldsymbol{f}_{k,j} = \left[f_{k,j}^{(1)} \cdots f_{k,j}^{(N_k)} \right]^T \in \mathbb{C}^{N_k \times 1}$ is a channel vector; $\boldsymbol{n}_{r,k}(t) \in \mathbb{C}^{N_k \times 1}$ is a zero-mean additive white Gaussian noise (AWGN) vector; and $\mathrm{E}\,\boldsymbol{n}_{r,k}(t)\boldsymbol{n}_{r,k}^*(t) = \sigma_{r,k}^2 \boldsymbol{I}_{N_k}$. The nth relay in the kth group multiplies the received signal by a complex valued weight, and forwards it to the destination through the second-hop. Denoting the weighting vector of the kth relay group by $\boldsymbol{w}_k \in \mathbb{C}^{N_k \times 1}$, the received signal $y_i(t)$ at the ith destination can be represented as:

$$y_i(t) = \sum_{k=1}^{K} \boldsymbol{g}_{i,k}^T \boldsymbol{W}_k \boldsymbol{r}_k(t) + n_{d,i}(t) \tag{2}$$

where $\boldsymbol{g}_{i,k} = \left[g_{i,k}^{(1)} \cdots g_{i,k}^{(N_k)} \right]^T \in \mathbb{C}^{N_k \times 1}$ is a channel vector; the diagonal matrix $\boldsymbol{W}_k = \mathrm{diag}(\boldsymbol{w}_k) \in \mathbb{C}^{N_k \times N_k}$; and $n_{d,i}(t)$ is the ith destination AWGN with variance $\sigma_{d,i}^2$. Throughout this paper, we assume (i) every channel remains static during the two transmission phases; (ii) the nth relay in the ith

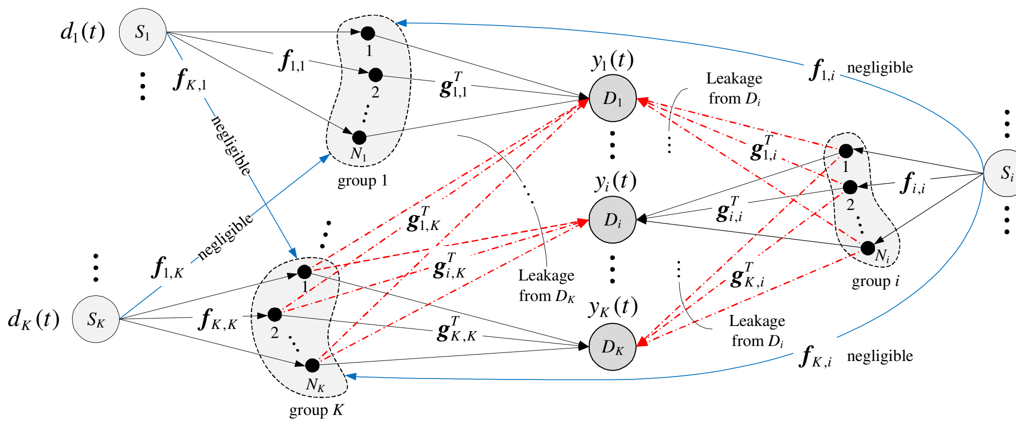

Fig. 1. Distributed multiple grouped-relays network model with K sources, K destinations, and K groups. The ith relay group consists of N_i relays.

group knows $\sigma_{r,i}^2$, $\sigma_{f,i,i}^{2(n)}$, and $\{\sigma_{g,k,i}^{2(n)}\}$ for all k by estimation through the first phase and by a signaling procedure from all destinations; (iii) using a transmit power control mechanism at the sources, the average received power at each relay group is identical; (iv) the relay belongs to only one group; (v) $\{\sigma_{f,i,i}^{2(1)}, \ldots, \sigma_{f,i,i}^{2(N_i)}\} \gg \{\sigma_{f,i,j}^{2(1)}, \ldots, \sigma_{f,i,j}^{2(N_i)}\} \simeq 0$, where $i \neq j$, from an intelligent selection of relays to comprise a group—this assumption is applicable to the cellular environment where each source is interpreted as base station in different cells and the destinations are interpreted as subscribers at the cell boundary; and (vi) the data symbols, channel elements, and noises are independent of one another.

III. Grouped-Relay Processing

Under assumptions (i) and (ii) mentioned above, the distributed relay processing $\{\boldsymbol{w}_k^{(n)}\}$, which is the nth relay weight in the kth group, for all $n \in \{1, \ldots, N_k\}$ and $k \in \{1, \ldots, K\}$, will be designed with the available information. Without loss of generality, from assumption (iii), we can set $\|\boldsymbol{w}_k\|^2 = 1$ as the relay transmit power constraint. Substituting (1) into (2), the received signal at the ith destination is given by

$$\begin{aligned} y_i = &\sum_{k=1}^{K} \boldsymbol{g}_{i,k}^T \boldsymbol{W}_k \boldsymbol{f}_{k,i} d_i + \sum_{k=1}^{K} \boldsymbol{g}_{i,k}^T \boldsymbol{W}_k \sum_{j=1, j\neq i}^{K} \boldsymbol{f}_{k,j} d_j \\ &+ \sum_{k=1}^{K} \boldsymbol{g}_{i,k}^T \boldsymbol{W}_k \boldsymbol{n}_{r,k} + n_{d,i} \end{aligned} \tag{3}$$

where the time index t is dropped for notational simplicity. The second term in (3) is the interference from the multiple sources and the third term is the colored noise from the grouped-relays.

From assumptions (iv) and (v), the received signal (3) can be approximated as:

$$\begin{aligned} y_i \approx\, &\boldsymbol{g}_{i,i}^T \boldsymbol{W}_i \boldsymbol{f}_{i,i} d_i + \sum_{k=1, k\neq i}^{K} \boldsymbol{g}_{i,k}^T \boldsymbol{W}_k \boldsymbol{f}_{k,k} d_k \\ &+ \sum_{k=1}^{K} \boldsymbol{g}_{i,k}^T \boldsymbol{W}_k \boldsymbol{n}_{r,k} + n_{d,i}. \end{aligned} \tag{4}$$

Taking expectation over the channels, the received SINR is derived from (4) as (5) at the bottom of this page under the assumption (vi), and it can be represented as

$$\overline{\mathrm{SINR}}_i = \frac{\boldsymbol{w}_i^* \boldsymbol{\Sigma}_i \boldsymbol{w}_i}{\sum_{k=1, k\neq i}^{K} \boldsymbol{w}_k^* \boldsymbol{\Phi}_{i,k} \boldsymbol{w}_k} \tag{6}$$

where the N_i- and N_k-dimensional covariance matrices $\boldsymbol{\Sigma}_i$ and $\boldsymbol{\Phi}_{i,k}$, respectively, are given by

$$\begin{aligned} \boldsymbol{\Sigma}_i &= \mathrm{E}\, \boldsymbol{G}_{i,i}^* \boldsymbol{F}_i \boldsymbol{G}_{i,i} \\ \boldsymbol{\Phi}_{i,k} &= \mathrm{E}\, \boldsymbol{G}_{i,k}^* \boldsymbol{F}_k \boldsymbol{G}_{i,k} + \sigma_{r,i}^2\, \mathrm{E}\, \boldsymbol{G}_{i,k}^* \boldsymbol{G}_{i,k} + \sigma_{d,i}^2 \boldsymbol{I}_{N_k} \end{aligned} \tag{7}$$

Here, $\boldsymbol{F}_i = (\boldsymbol{f}_{i,i} \boldsymbol{f}_{i,i}^*)^T \in \mathbb{C}^{N_i \times N_i}$ and $\boldsymbol{G}_{i,k} = \mathrm{diag}(\boldsymbol{g}_{i,k})$. Noting that $\boldsymbol{G}_{i,k}$ is a diagonal matrix and that the channel elements of $\boldsymbol{g}_{i,k}$ and $\boldsymbol{f}_{i,i}$ are independent of each other, we can obtain $\boldsymbol{\Sigma}_i$ and $\boldsymbol{\Phi}_{i,k}$ from (7) as

$$\boldsymbol{\Sigma}_i = \mathrm{diag}\left(\left[\sigma_{f,i,i}^{2(1)} \sigma_{g,i,i}^{2(1)} \ \cdots \ \sigma_{f,i,i}^{2(N_i)} \sigma_{g,i,i}^{2(N_i)} \right]^T \right) \tag{8a}$$

$$\boldsymbol{\Phi}_{i,k} = \mathrm{diag}\left(\left[\mu_{i,k}^{(1)} \ \cdots \ \mu_{i,k}^{(N_k)} \right]^T \right) \tag{8b}$$

where

$$\mu_{i,k}^{(n)} = \sigma_{f,i,k}^{2(n)} \sigma_{g,i,k}^{2(n)} + \sigma_{r,i}^2 \sigma_{g,i,k}^{2(n)} + \sigma_{d,i}^2.$$

$$\overline{\mathrm{SINR}}_i = \frac{\mathrm{E} \left| \boldsymbol{g}_{i,i}^T \boldsymbol{W}_i \boldsymbol{f}_{i,i} \right|^2}{\underbrace{\mathrm{E} \sum_{k=1, k\neq i}^{K} \left| \boldsymbol{g}_{i,k}^T \boldsymbol{W}_k \boldsymbol{f}_{k,k} \right|^2}_{\text{power of interference signal}} + \underbrace{\sigma_{r,i}^2\, \mathrm{E} \sum_{k=1, k\neq i}^{K} \left\| \boldsymbol{g}_{i,k}^T \boldsymbol{W}_k \right\|^2}_{\text{power of colored noise}} + \underbrace{\sigma_{d,i}^2}_{\text{power of white noise}}} \tag{5}$$

For determining the optimal distributed beamforming vectors $\{\boldsymbol{w}_k\}_{k=1}^K$ with respect to the system BER, we can formulate an optimization problem using the SINR expression in (6) for $i = \{1, \ldots, K\}$ as

$$\{\boldsymbol{w}_i^o\} = \arg \max_{\{\boldsymbol{w}_i \in \mathbb{C}^{N_i \times 1}\}} \{\min \overline{\mathrm{SINR}}_i\}, \text{ s.t. } \|\boldsymbol{w}_i\|^2 = 1. \quad (9)$$

However, due to the $\sum_{k=1}^K N_k$ coupled variables $\{\boldsymbol{w}_k\}$ in (6), the SINR criterion generally results in a challenging optimization problem [4], [5].

To avoid solving (9), the SLNR criterion in [4], [5] can be employed. It leads to a closed form characterization of the optimal $\{\boldsymbol{w}_k\}$ in terms of generalized eigenvalue problems. To begin with, note that the power of the desired signal component for the destination D_i is given by $|\boldsymbol{g}_{i,i}^T \boldsymbol{W}_i \boldsymbol{f}_{i,i}|^2$ from (4), and the interference power caused by the ith grouped-relay on the signal received by unintended destinations D_k, where $k \neq i$, is given by $|\boldsymbol{g}_{k,i}^T \boldsymbol{W}_i \boldsymbol{f}_{i,i}|^2$. We then define the *average signal leakage* from the ith destination D_i as the total power leaked from D_i to all unintended destinations D_k:

$$\text{average signal leakage} = \mathrm{E} \sum_{k=1, k\neq i}^{K} \left|\boldsymbol{g}_{k,i}^T \boldsymbol{W}_i \boldsymbol{f}_{i,i}\right|^2. \quad (10)$$

Similarly, note that the average power of the colored noise component from the ith grouped-relay for D_i is given by $\sigma_{r,i}^2 \, \mathrm{E} \|\boldsymbol{g}_{i,i}^T \boldsymbol{W}_i\|^2$, and the average interference power caused by colored noise from the ith grouped-relay on the signal received by D_k, where $k \neq i$, is given by $\sigma_{r,i}^2 \, \mathrm{E} \|\boldsymbol{g}_{k,i}^T \boldsymbol{W}_i\|^2$. We likewise define the *average noise leakage* from D_i, as the total power leaked from D_i to D_k:

$$\text{average noise leakage} = \sigma_{r,i}^2 \, \mathrm{E} \sum_{k=1, k\neq i}^{K} \left\|\boldsymbol{g}_{k,i}^T \boldsymbol{W}_i\right\|^2. \quad (11)$$

For each destination D_i, we would like its average signal power, $\mathrm{E} |\boldsymbol{g}_{i,i}^T \boldsymbol{W}_i \boldsymbol{f}_{i,i}|^2$, to be relatively large compared to the average noise power at its receiver, i.e., $\sigma_{r,i}^2 \, \mathrm{E} \|\boldsymbol{g}_{i,i}^T \boldsymbol{W}_i\|^2 + \sigma_{d,i}^2$. We would also like $\mathrm{E} |\boldsymbol{g}_{i,i}^T \boldsymbol{W}_i \boldsymbol{f}_{i,i}|^2$ to be relatively large compared to the average signal and noise power leaked from D_i to D_k, where $k \neq i$, i.e., (10) and (11). Consequently, the average SLNR is defined in (12) at the bottom of this page. Here, the numerator measures the average power of the signal intended for the destination D_i as the same as the numerator of SINR in (5), while the denominator measures the average signal and colored noise power that leak from D_i to all other destinations D_k in addition to the colored and white noise power at D_i. Now, we can formulate the following decoupled optimization problem for the ith grouped-relay to maximize $\overline{\mathrm{SLNR}}_i$ as follows:

$$\boldsymbol{w}_i^L = \arg \max_{\boldsymbol{w}_i \in \mathbb{C}^{N_i \times 1}} \overline{\mathrm{SLNR}}_i, \text{ s.t. } \|\boldsymbol{w}_i\|^2 = 1. \quad (13)$$

To solve problem (13), we reformulate $\overline{\mathrm{SINR}}_i$ into Rayleigh-Ritz ratio form as

$$\boldsymbol{w}_i^L = \arg \max_{\boldsymbol{w}_i \in \mathbb{C}^{N_i \times 1}} \frac{\boldsymbol{w}_i^* \boldsymbol{\Sigma}_i \boldsymbol{w}_i}{\boldsymbol{w}_i^* \boldsymbol{\Psi}_i \boldsymbol{w}_i}, \text{ s.t. } \|\boldsymbol{w}_i\|^2 = 1 \quad (14)$$

where the N_i-dimensional covariance matrix $\boldsymbol{\Psi}_i$ is given by

$$\boldsymbol{\Psi}_i = \mathrm{E} \sum_{k=1, k\neq i}^{K} \boldsymbol{G}_{k,i}^* \boldsymbol{F}_i \boldsymbol{G}_{k,i} + \sigma_{r,i}^2 \, \mathrm{E} \sum_{k=1}^{K} \boldsymbol{G}_{k,i}^* \boldsymbol{G}_{k,i} + \sigma_{d,i}^2 \boldsymbol{I}_{N_i}.$$

Now, (14) can be solved by appealing to the Rayleigh-Ritz quotient result [6], [7], as

$$\boldsymbol{w}_i^L \propto \max \text{generalized eigenvector} \{\boldsymbol{\Sigma}_i, \boldsymbol{\Psi}_i\} \quad (15)$$

in terms of the eigenvector corresponding to the largest generalized eigenvalue of the matrices $\boldsymbol{\Sigma}_i$ and $\boldsymbol{\Psi}_i$, which is represented as

$$\boldsymbol{\Psi}_i = \mathrm{diag}\left(\left[\nu_i^{(1)} \ \cdots \ \nu_i^{(N_i)}\right]^T\right) \quad (16)$$

where

$$\nu_i^{(n)} = \sigma_{f,i,i}^{2(n)} \sum_{k=1,\ k\neq i}^{K} \sigma_{g,k,i}^{2(n)} + \sigma_{r,i}^2 \sum_{k=1}^{K} \sigma_{g,k,i}^{2(n)} + \sigma_{d,i}^2.$$

Since $\boldsymbol{\Psi}_i$ is invertible, the generalized eigenvalue problem (15) reduces to a standard eigenvalue problem, namely

$$\boxed{\boldsymbol{w}_i^L \propto \max \text{eigenvector} \left(\boldsymbol{\Psi}_i^{-1} \boldsymbol{\Sigma}_i\right)} \quad (17)$$

in terms of the eigenvector that corresponds to the maximum eigenvalue of $\boldsymbol{\Psi}_i^{-1} \boldsymbol{\Sigma}_i$. Note that the eigenvalues of $\boldsymbol{\Psi}_i^{-1} \boldsymbol{\Sigma}_i$ are the diagonal elements of $\boldsymbol{\Psi}_i^{-1} \boldsymbol{\Sigma}_i$ and the eigenvector corresponding to the nth eigenvalue is given by $\boldsymbol{e}_n$, where the nth element of $\boldsymbol{e}_n$ is 1 and the other elements are 0s, since $\boldsymbol{\Sigma}_i$ and $\boldsymbol{\Psi}_i$ are diagonal matrices having positive real diagonal elements. In other words, the optimal beamforming vector for the ith relay group is obtained by selecting the nth relay that maximizes the average SLNR at the ith destination, and is given by

$$\overline{\mathrm{SLNR}}_i^{(n)} = \frac{\sigma_{f,i,i}^{2(n)} \sigma_{g,i,i}^{2(n)}}{\sigma_{f,i,i}^{2(n)} \sum_{k=1,\ k\neq i}^{K} \sigma_{g,k,i}^{2(n)} + \sigma_{r,i}^2 \sum_{k=1}^{K} \sigma_{g,k,i}^{2(n)} + \sigma_{d,i}^2} \quad (18)$$

$$\overline{\mathrm{SLNR}}_i \triangleq \frac{\mathrm{E}\left|\boldsymbol{f}_{i,i}^T \boldsymbol{G}_{i,i} \boldsymbol{w}_i\right|^2}{\underbrace{\mathrm{E} \sum_{k=1, k\neq i}^{K} \left|\boldsymbol{f}_{i,i}^T \boldsymbol{G}_{k,i} \boldsymbol{w}_i\right|^2}_{\text{average power of signal leakage}} + \underbrace{\sigma_{r,i}^2 \, \mathrm{E} \sum_{k=1, k\neq i}^{K} \|\boldsymbol{G}_{k,i} \boldsymbol{w}_i\|^2}_{\text{average power of noise leakage}} + \underbrace{\sigma_{r,i}^2 \, \mathrm{E} \|\boldsymbol{G}_{i,i} \boldsymbol{w}_i\|^2}_{\text{average power of colored noise}} + \underbrace{\sigma_{d,i}^2}_{\text{power of white noise}}} \quad (12)$$

from (8a) and (16). Consequently, the optimal problem in (17) is identical to the following problem:

$$\boxed{\boldsymbol{w}_i^L = \boldsymbol{e}_{n^L} \text{ where } n^L = \max_n \overline{\text{SLNR}}_i^{(n)}} \tag{19}$$

For the relay selection in (19), the nth relay in the ith group computes (18) under the assumption (ii) and shares this information with other relays in the same group. Finally, the only selected relay turns on and retransmits the received signal to the destination.

At the destination D_i equalization is performed as $\hat{d}_i = \left(\boldsymbol{g}_{i,i}^{(n^L)} \boldsymbol{f}_{i,i}^{(n^L)}\right)^{-1} y_i$ to reduce the channel effect from (4). For the equalization, throughout the second phase, D_i needs to estimate the down link channel value $\boldsymbol{g}_{i,i}^{(n^L)}$, and the n^Lth relay at the ith group also needs to inform the channel value $\boldsymbol{f}_{i,i}^{(n^L)}$ to D_i.

IV. Simulation Results

Computer simulations are conducted to evaluate the performance of the SLNR-based relay selection for grouped-relay networks. For comparison purposes, we consider three other methods: random relay selection, SINR-based relay selection, and SINR-based beamforming methods. The random selection method chooses a relay in the group randomly. The SINR-based selection method chooses a relay in the group to maximize the cost in (9) by comparing $(\Pi_{k=1}^K N_k)$ number of costs, which correspond to the set $\{\boldsymbol{w}_i = \boldsymbol{e}_n\}$. The SINR-based beamforming is also compared as an optimal method and it can be implemented by solving (9). However, since $\overline{\text{SINR}}$ is a coupled measure and the concavity of the cost $\min\{\overline{\text{SINR}}_i\}$ is not guaranteed (which can be verified numerically), we find the optimal beamforming weight by greedy search in $\sum_{k=1}^K N_k$-dimension in our simulation. The transmitted signals from the sources are modulated by quadrature phase-shift keying (QPSK) and their average power is one, i.e., $\text{E}\,\|d_i(t)\|^2 = 1$. We set $N_i = N$ and $\sigma_{r,i}^2 = \sigma_{d,i}^2 = 10^{-5}$, for all i. The channel condition is set as follows:

$$\{\sigma_{f,i,j}^{2(n)}\} = \begin{cases} 0 & i \neq j \\ 1 & i = j \end{cases} \text{ and } \{\sigma_{g,i,j}^{2(n)}\} = \begin{cases} \mathcal{U}[0,\eta] & i \neq j \\ 1 & i = j \end{cases}$$

for all n, where $\mathcal{U}[a,b]$ represents a random variable distributed uniformly between a and b. Under these conditions, the average received signal power at the destination is one and the maximum interference power is η. Here, we define the minimum signal-to-interference ratio (SIR) as $\frac{1}{\eta}$, and the system performance is then evaluated by system BER.

Figure 2 shows the system BER performance. As expected, the performance improves as the SIR increases; it is bounded in high $\frac{1}{\eta}$ due to the AWGN; and it slightly decreases as the number of users increases when $N = 2$ in high interference region ($\frac{1}{\eta} < 30\,\text{dB}$). In contrast to the random selection method, it is observed that the SLNR- and SINR-based methods achieve multiuser and relay diversities, especially in the low interference region ($\frac{1}{\eta} > 40\,\text{dB}$). The performance gap between the proposed SLNR-based selection and the optimal beamforming method is small and it becomes negligible as the interference decreases. Especially, when there is no interference, both metrics SLNR and SINR degenerate to the signal-to-noise ratio (SNR) resulting in identical BER performance. The proposed SLNR-based selection method has two merits in terms of the computational complexity and the required information at the relay nodes. It is obvious that the computational complexity of the SLNR-based method is substantially less than the SINR-based methods from the fact that $(\sum_{k=1}^K N_k)$ searches are required for obtaining $\{\boldsymbol{w}_k^L\}_{k=1}^K$. Furthermore, comparing (6) with (14), we can verify that the relays in the SLNR-based method require less information than those in the SINR-based method. Specifically, the relays in the ith group, $(2\sum_{k=1}^K N_k + 2)$ variances are required to obtain SINR, while $(\sum_{k=1}^K N_k + N_i + 2)$ variances are required to obtain SLNR.

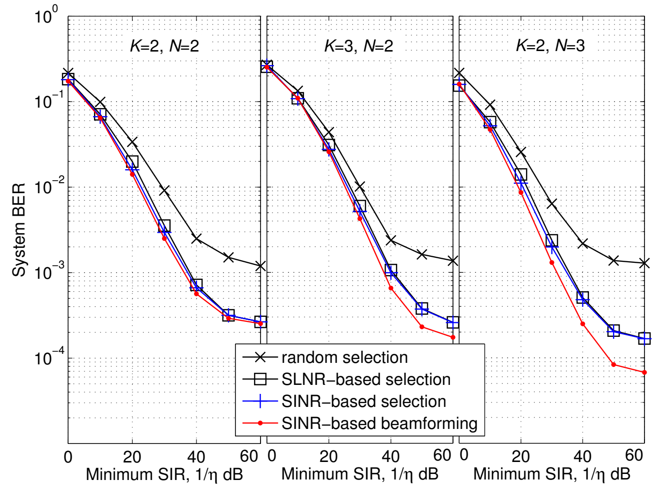

Fig. 2. System BER performance versus minimum SIR $\frac{1}{\eta}$.

V. Conclusion

We proposed an average SLNR-based relay selection method for grouped-relay networks. The numerical results show that the proposed relay selection method performs well compared to other more computationally intensive methods.

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