Partner Selection and Power Control for Asymmetrical Collaborative Networks

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***Abstract*—We derive an adaptive power control method for a collaborative network utilizing partner selection that aims to minimize the frame error rate (FER). We model a decode-and-forward (DF) collaborative network under block fading conditions, which contains M independent users utilizing codes, whose performance can be expressed by a signal to noise (SNR) threshold, such as turbo codes. We show that partner selection can reduce system complexity and power allocation can improve the FER performance. We use both a search method as well as a convex deterministic method to demonstrate our power allocation scheme. This research extends other work in which adaptive power allocation is only applied to limited scenarios. We conclude that power control can greatly benefit a DF collaborative network in a block fading environment.**

I. Introduction

A generic collaborative system contains users, which assist each other through sharing information [1]. The independent fading experienced on different paths gives rise to diversity, which can improve system performance. We model our cooperative scheme in the context of a fixed wireless access (FWA) network with arbitrary average channel SNRs; we shall call this an asymmetrical network. The motivation is to reduce the complexity of analysis through partner selection and then propose a sub-optimal channel-state-information (CSI) reliant power control scheme, and to compare its performance to that of optimal and equal power allocation. In our decode-and-forward (DF) collaboration system [2], we also derive theoretical frame error rate (FER) expressions. Simulations are used to verify the accuracy of our expressions.

Power allocation schemes exist in the form of the water-filling algorithms for amplify-and-forward (AF) cooperative networks [3], [4], [5], as well as for networks employing coded cooperation [6]. Whilst there has been work to solve power allocation for DF networks in both fading and Gaussian channels [7], complexity considerations have limited the optimization to only the relay-to-destination paths [8] and to the power distribution between two users [9]. Therefore, we believe that the power allocation of each user in DF networks under block fading remains a challenge, especially for networks with arbitrary channel quality (i.e. an asymmetrical network). We first simplify the problem through partner selection and then propose a sub-optimal power allocation method, which only relies on the short-term CSI and demonstrate the performance improvement. The proposed approach to power allocation is general in its methodology and may be applied to any system, whose link performance can be characterized using accurate error rate expressions, such as block coded DF networks [10] and symmetrical systems. In our case, we consider codes whose performance can be characterized by an signal to noise (SNR) threshold, such as turbo and convolutional codes.

Firstly, we define the cooperative system model, the channel fading environment and how power is allocated to each user. We then introduce the theoretical FER expressions for codes, whose performance in block fading channels can be characterized by an SNR threshold [11] in asymmetric uplink systems [12]. We then introduce optimal power constraints and propose a simple sub-optimal constraint to demonstrate our methodology and its performance improvement.

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II. System Model

The transmissions of all users are assumed to take place over Rayleigh block fading channels impaired by additive white Gaussian noise (AWGN). This is appropriate for a slowly changing environment such as that experienced in a FWA system. Within a block period, the channel gain coefficient remains constant, and any power adaption occurs between the fading blocks. In our system we define:

- *M*: the total number of users, and thus each user can have a maximum of $M-1$ cooperating partners.
- *i*: the ith user.
- *i'*: every other user with respect to user i ($i' \neq i$).
- *m*: for a particular user, we define $0 \leq m \leq M-1$ as the number of cooperating users at any instant fading block.
- *inter-user channel*: the channel linking a user to another user.
- *uplink channel*: the channel linking a user to the destination.

We define for the ith user: γ_i as the instantaneous and $\overline{\gamma}_i$ as average SNR of the uplink channel, and $\overline{\gamma}_{R_{i-i'}}$ is the average inter-user channel SNR to user i'. For fair comparison, we define an asymmetrical uplink system as one in which every user has a unique $\overline{\gamma}_i$. We denote the average SNR of all uplink channels as $\overline{\gamma}_{\text{avg}} = \frac{\sum_{i=1}^{M} \overline{\gamma}_i}{M}$, with the uplink deviation defined as: $\overline{\gamma}_{Di} = \overline{\gamma}_i - \overline{\gamma}_{\text{avg}}$ and a similar definition for the interuser deviation ($\overline{\gamma}_{D_{Ri-i'}}$). The greater the average deviation, the greater the asymmetry of the network. In a collaborative network, M users try to transmit independent information to the destination, using each other as their relays. For each fading block, there are M steps in such a system. The first step is always defined as a broadcasting step, where all M users broadcast their own data to each other and the destination with power P_{B_i}. After which, the remaining $M-1$ steps are left to be distributed between cooperation and no cooperation. As previously mentioned, m is the number of steps in which cooperation occurs, and $M-1-m$ for no cooperation, where $0 \leq m \leq M-1$. Cooperation occurs when a user can decode another user's data, which it subsequently re-encodes and transmits to the destination at power P_{C_i}. No cooperation occurs when there are remaining steps unused, where the user will retransmit its own data at power P_{NC_i}. If there is cooperation, the destination will perform maximum ratio combining (MRC) between the frame broadcasted in the first step, the m subsequent cooperation steps, and the $M-1-m$ retransmission steps. In no cooperation, the destination will combine the broadcast and retransmission step (P_{C_i}+P_{NC_i}) with no diversity gain. In the case of equal power allocation: $\text{P}_{\text{B}_i} = \text{P}_{\text{C}_i} = \text{P}_{\text{NC}_i} = \frac{1}{M}$.

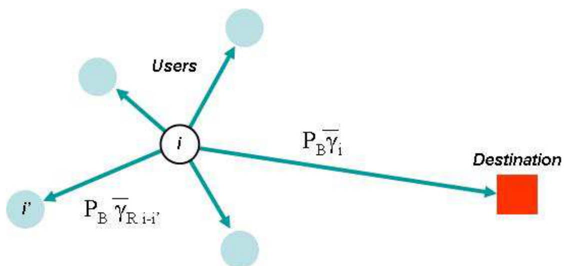

Fig. 1. The Broadcast Step of a Decode-and-Forward Cooperation Block for $M = 5$ Users

The scheme for $M = 5$ from user i's perspective is illustrated in Fig. 1. It shows user i broadcasting to all the other users, as well as the destination. Likewise, the other users also do the same (not shown). Subsequently, users may choose to cooperate despite no cooperation by the other partners, or form a consensus whereby cooperation only occurs mutually. The former scenario will be named "unselfish cooperation". We shall derive expressions for a M user unselfish network and then perform partner selection and optimize power allocation.

III. Error Rate Expressions

The following section finds the frame error rate for a coded system. We define the system frame error rate as the average of the user frame error rates. Each is composed of two essential error rate components: maximum ratio combining (MRC) and direct transmission (Direct). Respectively, they are the error rates owing to full cooperation and no cooperation. We first define a powerset $\mathcal{S}(M, m)$, which contains all the valid subset combinations for m cooperative partners, of which the subset $\mathcal{U}$ is part of. Hence, $\mathcal{S} \setminus \{\mathcal{U}\}$ is all the remaining subsets excluding $\mathcal{U}$. Therefore, the error rate of user i is:

$$\text{FER}_{\text{DF}_i} = \prod_{i'=1, i' \neq i}^{M-1} (1 - \wp_{i'-i}) \text{FER}_{\text{Direct}}(\overline{\gamma}_i) + \\ \sum_{m=1}^{M-1} \sum_{\mathcal{U} \epsilon \mathcal{S}} \prod_{i' \epsilon \mathcal{U}} \wp_{i-i'} \prod_{i' \epsilon \mathcal{S} \setminus \mathcal{U}} (1 - \wp_{i-i'}) \text{FER}_{\text{MRC}}(m, \overline{\gamma}_i). \tag{1}$$

Let T be the threshold of a turbo code; the direct no cooperation channel FER is [11]:

$$\text{FER}_{\text{Direct}}(\overline{\gamma}_i) = 1 - e^{-\frac{T}{\overline{\gamma}_i}}. \tag{2}$$

The probability of cooperation $\wp_i$ is the probability of no frame errors in the interuser channel ($1 - \text{FER}_{\text{Direct}}(\overline{\gamma}_R)$):

$$\wp_{i-i'} = e^{-\frac{T}{\overline{\gamma}_{R_{i-i'}}}}. \tag{3}$$

The $\text{FER}_{\text{MRC}}(m, \overline{\gamma}_i)$ term is the cooperation error rate with MRC, and $\text{FER}_{\text{Direct}}(\overline{\gamma}_i)$ is the no cooperation error rate; both of which we shall derive below. Similarly, from [12] the cooperation FER between user i and m other partners is:

$$\text{FER}_{\text{MRC}}(m, \overline{\gamma}_i) = \sum_{i=0}^{m} \prod_{i'=1, i' \neq i}^{m} \frac{\overline{\gamma}_i}{\overline{\gamma}_i - \overline{\gamma}_{i'}} (1 - e^{-\frac{T}{\overline{\gamma}_i}}). \tag{4}$$

It is important to note that if the uplink channels are symmetrical ($\overline{\gamma}_i = \overline{\gamma}_{i'}$), (4) is no longer applicable and a separate expression is needed [12]. From the above equations, we can assemble a user and a system's FER and optimize it through partner selection and power allocation. As previously stated, we define the system frame error rate as the average of all the user frame error rates ($\mathbf{f} = \frac{1}{M} \sum_{i=1}^{M} \text{FER}_{\text{DF}_i}$).

IV. Partner Selection

Before power allocation, we first examine partner selection to simplify the M user problem. The advantage of such a approach is the reduction of complexity and the increase in available power per data frame. We constrain our power usage so that each user has a fixed amount of energy. Therefore, the fewer partners with which a user has to cooperate with, the greater the power is available per data frame. However, there is a reduction in diversity as less available partners are utilized for cooperation. We

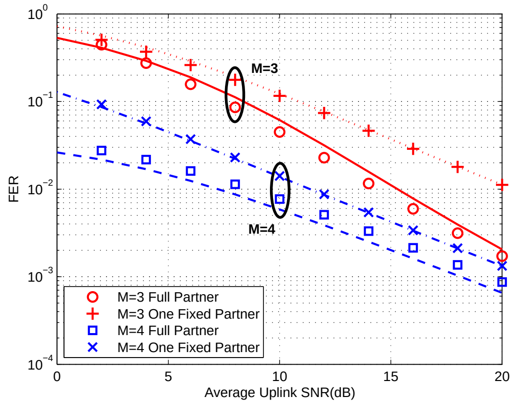

Fig. 2. Partner Selection for Collaborative Network with M=4 Users: $\overline{\gamma}_{D_i} = -9, -8, 5, 12$dB; and M=3 Users: $\overline{\gamma}_{D_i} = -18, -7, -5$dB. The system has $\overline{\gamma}_{D_{Ri-i'}} = -5, -3, -1, 2, 3, 4$dB, and $\overline{\gamma}_{R_{avg}} = 5$dB

consider a simple form of partner selection where each user picks one partner based on a CSI criterion. First we define the harmonic mean of user i's channels with respect to a partner i':

$$h_i = \frac{2}{\frac{1}{\overline{\gamma}_{R_{i-i'}}} + \frac{1}{\overline{\gamma}_i}}. \quad (5)$$

Similarly, we define the harmonic mean of a partnership to be between h_i and $h_{i'}$. We then minimize the difference between the average harmonic mean of all partnerships, thus creating partnerships of similar channel quality. This is a modified and long term version of the instantaneous relay selection criterion used in [13]. We did experiment with other partner selection schemes, but this method was found to be the most consistently effective and simple scheme. We will then allocate power based on this partnership and analyze the performance. Fig. 2 shows that selecting a partner and concentrating the power allocation, can give comparable performances to full diversity selection, whilst reducing the complexity of the analysis. Symbols indicate simulation and lines indicate theoretical expressions. In the cases where M is odd, there will be one un-partnered user. Therefore, $M = 3$ is the worst case performance scenario. After partner selection, the system FER becomes the average FER of all partnerships. Therefore, for a specific partnership, we can use the previous FER function (1) for the $M = 2$ case:

$$\begin{aligned}\mathbf{f} =& e^{-\frac{T}{\mathrm{P_{B_1}}\overline{\gamma}_R}}\left[\frac{\mathrm{P_{B_1}}\overline{\gamma}_1(1-e^{-\frac{T}{\mathrm{P_{B_1}}\overline{\gamma}_1}})}{\mathrm{P_{B_1}}\overline{\gamma}_1 - \mathrm{P_{C_2}}\overline{\gamma}_2} + \frac{\mathrm{P_{C_2}}\overline{\gamma}_2(1-e^{-\frac{T}{\mathrm{P_{C_2}}\overline{\gamma}_2}})}{\mathrm{P_{C_2}}\overline{\gamma}_2 - \mathrm{P_{B_1}}\overline{\gamma}_1}\right] \\ &+ e^{-\frac{T}{\mathrm{P_{B_2}}\overline{\gamma}_R}}\left[\frac{\mathrm{P_{B_2}}\overline{\gamma}_2(1-e^{-\frac{T}{\mathrm{P_{B_2}}\overline{\gamma}_2}})}{\mathrm{P_{B_2}}\overline{\gamma}_2 - \mathrm{P_{C_1}}\overline{\gamma}_1} + \frac{\mathrm{P_{C_1}}\overline{\gamma}_1(1-e^{-\frac{T}{\mathrm{P_{C_1}}\overline{\gamma}_1}})}{\mathrm{P_{C_1}}\overline{\gamma}_1 - \mathrm{P_{B_2}}\overline{\gamma}_2}\right] \\ &+ (1-e^{-\frac{T}{\mathrm{P_{B_2}}\overline{\gamma}_R}})(1-e^{-\frac{T}{\overline{\gamma}_1}}) + (1-e^{-\frac{T}{\mathrm{P_{B_1}}\overline{\gamma}_R}})(1-e^{-\frac{T}{\overline{\gamma}_2}}).\end{aligned} \quad (6)$$

We note that $\overline{\gamma}_{R_{i-i'}} = \overline{\gamma}_R$, since the interuser channels are assumed reciprocal in a specific partnership. The resulting partnership is a special case of the generic situation described earlier. We have simplified the system, where $M = 2$ and $m = 0, 1$. We will now look at applying a power constraint and optimizing power allocation for the FER function (6).

V. Power Constraint

Fig. 1 has illustrated that for each user, there are two steps for a DF collaborative network. Step one is broadcast, and step two (which is repeated $M-1$ times) is for cooperation. Having performed partner selection, where each user is paired with another user, cooperation complexity has been reduced from M to 2. The factors previously illustrated in Fig. 1 are all set to $\frac{1}{M}$ in the case of equal power allocation. For the schemes to be fair and comparable to each other, we add a power constraint whereby the amount of power available to each user is fixed (unity per block). We consider a short term power allocation, where we conserve power within one fading block. Since each partnership only has $M = 2$ users, there are only 2 steps per fading block. The first broadcast step has power allocation factor $\mathrm{P_{B_i}}$, and the subsequent step has power $\mathrm{P_{C_i}} = \mathrm{P_{NC_i}} = 1 - \mathrm{P_{B_i}}$. This is not as flexible as a long term power allocation scheme, but only requires the CSI of the current cooperation block to perform accurate optimization. The constraint is:

$$\mathrm{P_{B_i}} + \mathrm{P_{C_i}} = 1, \quad (7)$$

where $\mathrm{P_{C_i}}$ both represents the power allocation for cooperation and non-cooperation data frames ($\mathrm{P_{C_i}} = \mathrm{P_{NC_i}}$). We also assume that under no cooperation the destination does not perform combining and uses the power allocation factor $\mathrm{P_{C_i}}$. We will demonstrate the gains of the single factor scheme, both in theory and simulation. We shall now present two methods for power allocation: a search method and convex deterministic method.

VI. Power Allocation: Search Method

We first utilize a brute force search approach, which searches along all valid FER possibilities, subject to the power constraint. This may be seen as a optimal solution for our error rate minimization approach. The search range for power allocation factors is finite and between 0 and 1 at most in order for both power allocation factors to be positive under (7) .

VII. Power Allocation: Deterministic Method

A. Convexity Introduction

In order for a deterministic power optimization to produce unique solutions which provide the lowest system FER, we must ensure the objective system FER equation and the power constraint equation are both convex, as defined in [14]. To do so, we examine the second-order partial derivatives of the FER and constraint functions.

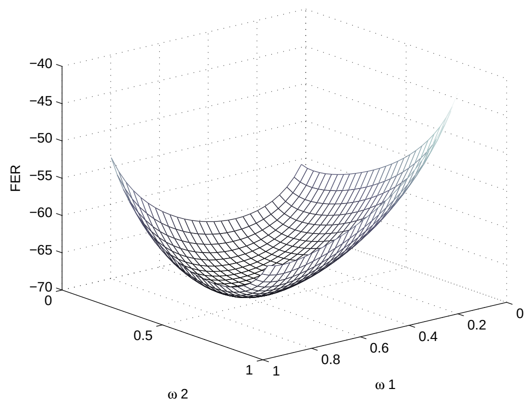

Fig. 3. Plot of FER Surface for Asymmetrical Uplink Channels with Single Factor Power Constraint, under Average Relay SNR 10dB

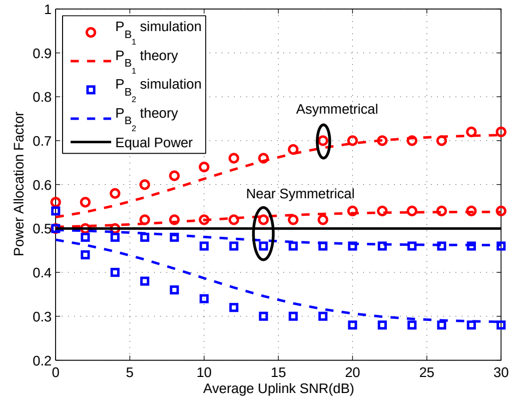

Fig. 4. Power Allocation Factors for asymmetric and near symmetric systems

When the derivatives are formed into a square matrix, it is known as the Hessian matrix. The Hessian is used to show whether the functions are semi-definite positive; or in other words: convex. We define $\mathbf{F}$ as the Hessian for the objective FER function (6), and $\mathbf{H}$ for the constraint (7). Thus, the convexity requirements are:

$$v^T \begin{bmatrix} \frac{\partial^2 f}{\partial \mathrm{P}_{\mathrm{B}_1}^2} & \frac{\partial^2 f}{\partial \mathrm{P}_{\mathrm{B}_1} \partial \mathrm{P}_{\mathrm{B}_2}} \\ \frac{\partial^2 f}{\partial \mathrm{P}_{\mathrm{B}_2} \partial \mathrm{P}_{\mathrm{B}_1}} & \frac{\partial^2 f}{\partial \mathrm{P}_{\mathrm{B}_2}^2} \end{bmatrix} v \succeq 0, \quad (8)$$

and

$$v^T \begin{bmatrix} \frac{\partial^2 h}{\partial \mathrm{P}_{\mathrm{B}_1}^2} & \frac{\partial^2 h}{\partial \mathrm{P}_{\mathrm{B}_1} \partial \mathrm{P}_{\mathrm{B}_2}} \\ \frac{\partial^2 h}{\partial \mathrm{P}_{\mathrm{B}_2} \partial \mathrm{P}_{\mathrm{B}_1}} & \frac{\partial^2 h}{\partial \mathrm{P}_{\mathrm{B}_2}^2} \end{bmatrix} v \succeq 0, \quad (9)$$

for all non-zero vectors $v = [v_1, v_2]$, with real entries ($v \in \mathbb{R}^n$). The channel is asymmetric, thus one uplink is always greater than another ($\overline{\gamma}_1 > \overline{\gamma}_2$), and we also assume that all channel SNRs are stronger than the threshold SNR (T). We now perform the same convexity analysis:

$$\mathbf{F} \simeq \begin{bmatrix} A(\overline{\gamma}_1 - \overline{\gamma}_2) & B(\overline{\gamma}_1 - \overline{\gamma}_2) \\ B(\overline{\gamma}_1 - \overline{\gamma}_2) & C(\overline{\gamma}_1 + \overline{\gamma}_2) \end{bmatrix}, \quad (10)$$

where A, B, and C are always positive and small. We assumed that $\overline{\gamma}_1 > \overline{\gamma}_2$, and therefore (10) is semi-definite positive. The Hessian for the power constraint is null ($\mathbf{H} = 0$), and thus the problem of power allocation is convex. The objective function's convexity without approximations is shown in Fig. 3. Therefore, we can proceed to finding a deterministic power allocation method by using Lagrangian multipliers to find the minimum FER under the power constraint.

B. Deterministic Power Allocation

We use Lagrangian multipliers to find the power allocation factors which minimizes the system FER, subject to the previous partner selection scheme. We define the Lagrangian Λ:

$$\begin{aligned} \Lambda =& f(\mathrm{P}_{\mathrm{B}_1}, \mathrm{P}_{\mathrm{B}_2}) + \lambda g(\mathrm{P}_{\mathrm{B}_1}) + \zeta h(\mathrm{P}_{\mathrm{B}_2}) \\ =& e^{-\frac{T}{\mathrm{P}_{\mathrm{B}_1}\overline{\gamma}_R}} \Big[\frac{\mathrm{P}_{\mathrm{B}_1}\overline{\gamma}_1(1 - e^{-\frac{T}{\mathrm{P}_{\mathrm{B}_1}\overline{\gamma}_1}})}{\mathrm{P}_{\mathrm{B}_1}\overline{\gamma}_1 - \mathrm{P}_{\mathrm{C}_2}\overline{\gamma}_2} + \frac{\mathrm{P}_{\mathrm{C}_2}\overline{\gamma}_2(1 - e^{-\frac{T}{\mathrm{P}_{\mathrm{C}_2}\overline{\gamma}_2}})}{\mathrm{P}_{\mathrm{C}_2}\overline{\gamma}_2 - \mathrm{P}_{\mathrm{B}_1}\overline{\gamma}_1}\Big] \\ &+ e^{-\frac{T}{\mathrm{P}_{\mathrm{B}_2}\overline{\gamma}_R}} \Big[\frac{\mathrm{P}_{\mathrm{B}_2}\overline{\gamma}_2(1 - e^{-\frac{T}{\mathrm{P}_{\mathrm{B}_2}\overline{\gamma}_2}})}{\mathrm{P}_{\mathrm{B}_2}\overline{\gamma}_2 - \mathrm{P}_{\mathrm{C}_1}\overline{\gamma}_1} + \frac{\mathrm{P}_{\mathrm{C}_1}\overline{\gamma}_1(1 - e^{-\frac{T}{\mathrm{P}_{\mathrm{C}_1}\overline{\gamma}_1}})}{\mathrm{P}_{\mathrm{C}_1}\overline{\gamma}_1 - \mathrm{P}_{\mathrm{B}_2}\overline{\gamma}_2}\Big] \\ &+ (1 - e^{-\frac{T}{\mathrm{P}_{\mathrm{B}_2}\overline{\gamma}_R}})(1 - e^{-\frac{T}{\mathrm{P}_{\mathrm{C}_1}\overline{\gamma}_1}}) + (1 - e^{-\frac{T}{\mathrm{P}_{\mathrm{B}_1}\overline{\gamma}_R}})(1 - e^{-\frac{T}{\mathrm{P}_{\mathrm{C}_2}\overline{\gamma}_2}}) \\ &+ \lambda[\mathrm{P}_{\mathrm{B}_1} + (1 - \mathrm{P}_{\mathrm{B}_1}) - 1] + \zeta[\mathrm{P}_{\mathrm{B}_2} + (1 - \mathrm{P}_{\mathrm{B}_2}) - 1]. \end{aligned} \quad (11)$$

By forming the partial derivatives $(\frac{\partial \Lambda}{\partial \mathrm{P}_{\mathrm{B}_1}}, \frac{\partial \Lambda}{\partial \mathrm{P}_{\mathrm{B}_2}}, \frac{\partial \Lambda}{\partial \lambda}, \frac{\partial \Lambda}{\partial \zeta})$ and then combining the independent equations under the assumption: $\overline{\gamma}_1 > \overline{\gamma}_2$, we find:

$$\mathrm{P}_{\mathrm{B}_1} = \frac{(\frac{\overline{\gamma}_R + \overline{\gamma}_1}{\overline{\gamma}_R + \overline{\gamma}_2})^{\frac{1}{3}}}{1 + (\frac{\overline{\gamma}_R + \overline{\gamma}_1}{\overline{\gamma}_R + \overline{\gamma}_2})^{\frac{1}{3}}}. \quad (12)$$

Likewise, the power allocation bound for user 2 has a similar form:

$$\mathrm{P}_{\mathrm{B}_2} = \frac{(\frac{\overline{\gamma}_R + \overline{\gamma}_2}{\overline{\gamma}_R + \overline{\gamma}_1})^{\frac{1}{3}}}{1 + (\frac{\overline{\gamma}_R + \overline{\gamma}_2}{\overline{\gamma}_R + \overline{\gamma}_1})^{\frac{1}{3}}}. \quad (13)$$

From (12), we can see that a symmetric system $\overline{\gamma_1} = \overline{\gamma_2}$ would reduce the scheme to equal power allocation. It is also worth noting that an unintended result of the power allocation scheme is: $1 - \mathrm{P}_{\mathrm{B}_1} = \mathrm{P}_{\mathrm{B}_2}$.

VIII. Performance Results and Discussion

We now demonstrate the effectiveness of power allocation using turbo codes with generator polynomials $(1, 5/7, 5/7)$ in octal form, a threshold of -4.4dB, and an input frame size of 256. Each simulation result (symbols) is reinforced by theory (lines). Fig. 4 shows the results of the search theory (symbols) and deterministic theory (lines)

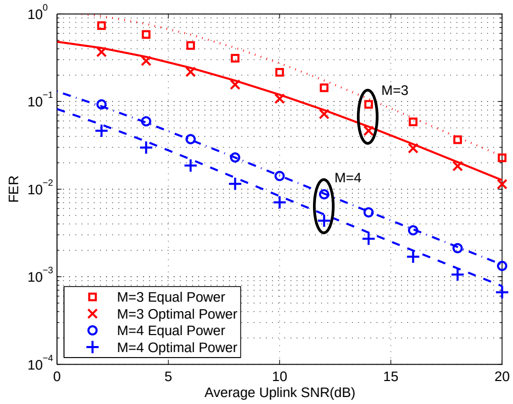

Fig. 5. Performance Gain from power allocation with M=4 Users: $\overline{\gamma}_{D_i} = -9, -8, 5, 12$dB; and M=3 Users: $\overline{\gamma}_{D_i} = -18, -7, -5$dB. The system has $\overline{\gamma}_{D_{Ri-i'}} = -5, -3, -1, 2, 3, 4$dB, and $\overline{\gamma}_{R_{avg}} = 5$dB

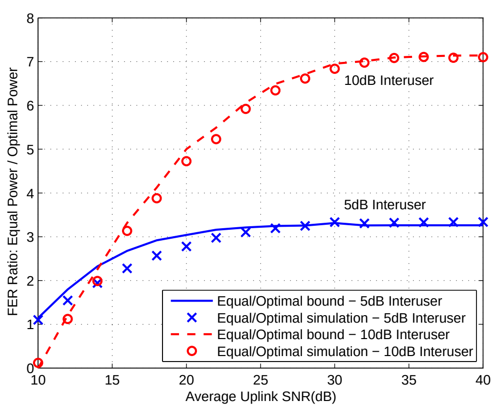

Fig. 6. FER ratio between equal and deterministic power allocation schemes for $M = 2$ unselfish users

for power allocation. We observe the close match given by the deterministic method (12), especially at medium-high average uplink SNRs. The results indicate that equal power allocation is optimal for both users in near symmetric uplink conditions $\overline{\gamma}_D \leq 0dB$. Fig. 5 shows the gain achieved by power allocation: the simulation (symbols) and deterministic theory (lines). We see that by performing partner selection to simplify the analysis and then performing sub-optimal power allocation we have improved the FER performance compared to equal power allocation. We now derive performance bound of the ratio between adaptive over that of equal power allocation with partner selection ($M = 2$), assuming $\overline{\gamma}_1 > \overline{\gamma}_2$:

$$\text{Ratio} \simeq \frac{4}{(1 + (\frac{\overline{\gamma}_R + \overline{\gamma}_2}{\overline{\gamma}_R + \overline{\gamma}_1})^{\frac{1}{3}})^2}. \quad (14)$$

Fig. 6 shows that our theoretical performance gain matches the simulation results. We show from (14), the greater the ratio of asymmetry between uplink channels ($\frac{\overline{\gamma}_1}{\overline{\gamma}_2}$) the greater the power allocation gain achieved.

IX. Conclusion

We began by finding approximated closed form expressions for the FER of turbo codes in asymmetrical block faded channels. This was extended to address a decode-and-forward cooperative system where we analyzed the FER performance of a partner selection scheme. We proposed a sub-optimal short term allocation scheme, which offered a performance improvement without involving long term CSI. This method produced deterministic power allocation expressions that perform close to those of the optimal search method. Under a symmetrical system with high channel SNRs, our power allocation method reduces to equal power allocation. The proposed approach can be extended to other codes whose error rate performance can be characterized by an SNR threshold.

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