Precoder Design for MU-MISO Transmission with Guaranteed QoS Constraints

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***Abstract*—We study the problem of designing transmit beamformer for maximizing the weight sum rate of a multi-user (MU)-multiple-input single-output (MISO) interference broadcast channel (IBC) with individual quality-of-service (QoS) constraints. The considered problem is known to be nonconvex and NP-hard indeed, and most of existing high-performance solutions are based on the centralized method. In this paper, we propose a distributed approach for the weighted sum rate maximization (WSRM) problem with QoS constraints by combining successive convex approximation (SCA) framework and the alternating directions method of multipliers (ADMM) technique. More specifically, the proposed algorithm extends a current centralized solution, where the SCA is used to arrive at an approximate convex problem at each step of the iterative procedure. The idea is that we apply the ADMM technique to solve the convex problem of the SCA based subproblem in a distributed manner. We also discuss some heuristic ways to accelerate the convergence rate of the proposed algorithm. Numerical simulations are provided to compare different models for both centralized and distributed algorithms.**

I. Introduction

The multiple-input multiple-output (MIMO) interference broadcast channel (IBC) is perhaps the most fundamental system model in wireless communications. In MIMO IBC each base station (BS) transmits data to users in there own cell, and thereby creates interference to the users of neighboring cells. The MIMO IBC is so general that it can include several scenarios as a special case such as cognitive radio systems, ad-hoc wireless networks, wireless cellular communication. For MIMO IBCs dirty paper coding (DPC) is known to be the capacity-achieving scheme [1], [2]. However, it is a nonlinear transmission technique which is based on non causal knowledge of interference state of transmitted signals and thus is very complex to implement. For the sake of complexity, linear precoding have been widely considered in the literature and is also adopted in this paper.

The weighted sum rate maximization (WSRM) problem is known to be nonconvex and NP-hard even for single-antenna receivers [3]. Our main aim is to design transmit precoders with the WSRM objective in addition to the user specific quality-of-service (QoS) requirements in terms of guaranteed minimum rate [4]–[6]. Several optimal solutions are proposed in [7]–[9]. In [7], transmit precoders are designed by using branch and bound technique to solve WSRM problem via feasibility subproblems for a given signal-to-interference-plus-noise-ratio (SINR). It is also numerically shown that the suboptimal designs that achieve the necessary conditions of the WSRM problem performs close to the optimal design. Among suboptimal solution, there exists a class of beamformer designs which are based on achieving the necessary optimal conditions of the WSRM problem, as can be seen in, [10]–[13]. In [10], the iterative coordinated beamforming algorithm was proposed by manipulating the Karush-Kuhn-Tucker (KKT) equations. However, this method is not provably convergent. On the contrary, [12], [13] solved the WSRM problem by utilizing the relation between SINR and mean squared error (MSE) expression upon using minimum mean squared error (MMSE) receivers. Similarly, In [14], the WSRM problem is solved by employing successive convex approximation (SCA) method for the MSE reformulated problem. The algorithm in [14] has better initial convergence than the methods proposed in [12], [13] in spite of reaching the same objective upon convergence. But these methods may not be practically feasible, since the complexity of finding optimal designs grows exponentially with the problem size. Hence, the need of computationally conducive suboptimal solutions to the WSRM problem still remains, as discussed in [15].

In this paper, we propose a decentralized weighted sum rate maximization with QoS constraints for multi-user (MU) multiple-input single-output (MISO) system. The centralized precoder design proposed in [15] for the WSRM objective is extended to a decentralized precoder design by including an additional QoS constraint. In order to do so, we adopt the alternating directions method of multipliers (ADMM) technique wherein the the coupling interference constraints are relaxed by introducing a BS specific local interference variables and the respective global interference value. Then, the precoders are decoupled by taking the partial Lagrangian of the equality constraint between the BS specific variables and the global consensus variables in the objective. However, to ensure the coordination among the coupling BSs, the global consensus values and the BS specific local interference values are augmented in the objective with a suitable pricing or dual variable, which is updated by exchanging the BS specific local copies among the coordinating BSs. Even though we consider ADMM based distributed precoder design with minimum QoS constraints, prior work on this topic has been considered in [6], [16], [17] wherein the precoders are design to provide certain guaranteed QoS requirement with the objective of minimizing the total transmit power. The distributed design in [17] is performed by the dual decomposition method. A similar ADMM based decentralized precoder design is discussed in [6], where the transmit precoders are designed by using the SCA scheme. The proposed ADMM based design is compared to the centralized solution in terms of the sum rate and the achievable rate for each user based on the QoS requirements.

II. System Model and Problem Formulation

A. System Model

We consider a downlink MISO IBC system consisting of N_{B} coordinating BSs with N_{T} transmit antennas each and K single antenna receivers. By coordination, we mean that all BSs cooperate to design the transmit precoders to minimize the inter-cell interference without sharing their transmitted data. The set of all K user indices is denoted by $\mathcal{U} = \{1, 2, \ldots, K\}$. We assume that data for the k^{th} user is transmitted from its serving BS denoted by $b_k \in \mathcal{B}$, where $\mathcal{B} \triangleq \{1, 2, \ldots, N_B\}$ is the set of all coordinating BS indices. We denote by $\mathcal{U}_b$ as the set of all users served by BS b. Without loss of generality, we assume that all receivers know the corresponding channel state information (CSI) between serving BS, *i.e.*, $\mathbf{h}_{b_k,k}$, to decode the transmitted symbols associated with each user k. With flat fading channel model, the input-output relation for the k^{th} user is given by

$$y_k = \mathbf{h}_{b_k,k}\mathbf{w}_k d_k + \sum_{i=1, i\neq k}^{K} \mathbf{h}_{b_i,k}\mathbf{w}_i d_i + n_k. \quad (1)$$

where $\mathbf{h}_{b_i,k} \in \mathbb{C}^{1\times N_T}$ is the channel (row) vector between BS b_i and user k. In (1), $n \sim \mathcal{CN}(0, \sigma^2)$ is zero-mean circularly symmetric complex Gaussian noise with variance σ^2, d_k is the normalized data symbol, and $\mathbf{w}_k \in \mathbb{C}^{N_T\times 1}$ is the linear precoding vector.

The term $\sum_{i=1,i\neq k}^{K} \mathbf{h}_{b_i,k}\mathbf{w}_i d_i$ in (1) includes both intra-cell and inter-cell interference components. The total transmit power of BS b is given by the constraint $\sum_{k\in\mathcal{U}_b} \|\mathbf{w}_k\|^2 \leq P_b$ with P_b as the maximum available transmit power budget, and the SINR Γ_k corresponding to user k is given as

$$\Gamma_k(\{\mathbf{w}_k\}) = \frac{|\mathbf{h}_{b_k,k}\mathbf{w}_k|^2}{\sigma^2 + \sum_{i=1,i\neq k}^{K} |\mathbf{h}_{b_i,k}\mathbf{w}_i|^2}. \quad (2)$$

B. Problem Formulation

The precoder design for the WSRM problem with QoS constraints can be formulated as

$$\underset{\{\mathbf{w}_k\}}{\text{maximize}} \quad \sum_{k=1}^{K} \alpha_k \log(1 + \Gamma_k(\{\mathbf{w}_k\})) \quad (3a)$$

$$\text{subject to} \quad \sum_{k\in\mathcal{U}_b} \|\mathbf{w}_k\|^2 \leq P_b, \forall\, b \in \mathcal{B} \quad (3b)$$

$$\log(1 + \Gamma_k(\{\mathbf{w}_k\})) \geq R_k, \, \forall k \in \mathcal{U}. \quad (3c)$$

where $\Gamma_k(\{\mathbf{w}_k\})$ is defined in (2) and α_k is a positive weighting factor for user k which is typically introduced to maintain a certain degree of fairness among the users. The total transmit power constraint is given in (3b) and the minimum guaranteed QoS requirement is ensured by (3c).

III. Centralized Solution

In this section, we briefly introduce a solution for the centralized problem introduced in (3) with QoS constraint by following the similar approach presented in [15]. Since (2) cannot be handled directly due to the equality constraint, we introduce γ_k as an optimization variable to replace Γ_k, thereby acting as an under estimator for the actual SINR Γ_k. Now, we replace (2) by the following inequalities.

$$\gamma_k \leq \frac{|\mathbf{h}_{b_k,k}\mathbf{w}_k|^2}{\beta_k} \quad (4a)$$

$$\beta_k \geq \sigma^2 + \textstyle\sum_{i=1,i\neq k}^{K} |\mathbf{h}_{b_i,k}\mathbf{w}_i|^2, \quad (4b)$$

where (4a) is an under-estimator of SINR and (4b) provides an upper-bound on the total interference seen by all the users $k \in \mathcal{U}_b$, denoted as β_k. Thus, we can replace constraint (2) in the problem (3) by an equivalent and tractable constraint in (4) to solve the WSRM problem. It can be shown that the constraints in (4) hold with equality at optimum. It follows from the fact that to maximize sum rate, γ_k has to be maximized, *i.e.*, the interference limit term β_k has to decrease. In order to reduce β_k, (4b) must be tight, thereby making the above relaxation to hold with equality at optimum.

In order to find an optimal solution for the problem, we can observe that (4a) is the only nonconvex constraint. However, to solve we find a convex subset for the nonconvex constraint (4a). To do so, we consider the following equivalent representation for the constraint as

$$\Re(\mathbf{h}_{b_k,k}\mathbf{w}_k) \geq \sqrt{\gamma_k\beta_k} \quad (5a)$$

$$\Im(\mathbf{h}_{b_k,k}\mathbf{w}_k) = 0 \quad (5b)$$

where (5b) is used to restrict the transmit phase of $\mathbf{w}_k$ without affecting the objective. Moreover, making the imaginary part to zero does not affect the optimality of (4), since phase rotation on $\mathbf{w}_k$ will result in the same objective while satisfying all constraints.

We observe that the r.h.s of (5a) is geometric mean, and therefore we can bound it by a suitable convex upper approximation, *i.e.*, the arithmetic mean as mentioned in [15], [18]

$$\sqrt{\gamma_k\beta_k} \;\leq\; \gamma_k\frac{\phi_k^{(i)}}{2} + \beta_k\frac{1}{2\phi_k^{(i)}} \;\triangleq\; f(\gamma_k, \beta_k, \phi_k^{(i)}). \quad (6)$$

The inequality in (6) is valid for all ϕ but it will be equal if the parametric constant $\phi_k^{(i)}$ is chosen as

$$\phi_k^{(i)} = \sqrt{\frac{\beta_k^{(i-1)}}{\gamma_k^{(i-1)}}} \quad (7)$$

where $\beta_k^{(i)}$ and $\gamma_k^{(i)}$ are the solution obtained by solving (4) with the approximation (6) in ith iteration for β_k and γ_k, respectively. Using (6) and (7), we can easily show that

$$\lim_{i\to\infty} f(\gamma_k, \beta_k, \phi_k^{(i)}) \to \sqrt{\gamma_k^* \beta_k^*} \tag{8}$$

where $\sqrt{\gamma_k^* \beta_k^*}$ is the optimal value upon convergence of the sequential parametric convex approximation (SPCA) procedure [18]. Finally, the SPCA based iterative precoder design with the WSRM objective is given by

$$\underset{\{\mathbf{w}_k\},\{\gamma_k\},\{\beta_k\}}{\text{maximize}} \quad \sum_b \sum_{k\in\mathcal{U}_b} \alpha_k \log(1+\gamma_k) \tag{9a}$$

$$\text{subject to} \quad \Im(\mathbf{h}_{b_k,k}\mathbf{w}_k) = 0 \tag{9b}$$

$$\Re(\mathbf{h}_{b_k,k}\mathbf{w}_k) \geq \frac{\gamma_k\, \phi_k^{(i)}}{2} + \frac{\beta_k}{2\phi_k^{(i)}}, \forall k \tag{9c}$$

$$\beta_k \geq \sigma^2 + \sum_{i=1, i\neq k}^{K} |\mathbf{h}_{b_i,k}\mathbf{w}_i|^2, \forall k \tag{9d}$$

$$\sum_{k\in\mathcal{U}_b} \|\mathbf{w}_k\|_2^2 \leq P_b, \forall b \in \mathcal{B} \tag{9e}$$

$$(1+\gamma_k) = \exp(R_k), \forall k, \tag{9f}$$

where $\exp(R_k)$ is a constant. The problem in (9) is solved until convergence, *i.e.*, $i \to \infty$.

IV. ADMM based Distributed Precoder Designs

In this section, we consider the problem of distributed precoder design using the ADMM with the objective of maximizing the sum rate of all users with an additional QoS constraint in the form of minimum guaranteed rate requirement. Similar work has been considered in [4]–[6], where the precoders are designed by exploiting the MSE equivalence with the SINR expression. However, due to requirement of the MMSE receiver at the user terminals, it involves alternating optimization (AO) technique to update transmit and receive beamformers alternatively until convergence even for single antenna user terminals.

The QoS requirements are usually guided by the service type associated with each transmission. For example, in order to provide an appreciable call quality in voice over IP (VoIP) service, a BS should ensure certain minimum guaranteed rate requirement for VoIP users. The precoders are designed at each BS by exchanging the coupling interference across backhaul that interconnects the coordinating BSs. In order to distribute the convex subproblem in (9), we adopt ADMM technique by introducing additional optimization variables for the constraint (9d) as define in [17] for BS b and $\forall k \in \mathcal{U}_{b_k}$ as

$$\beta_k \geq \sigma^2 + \sum_{i\in\mathcal{U}_b, i\neq k} |\mathbf{h}_{b,k}\mathbf{w}_i|^2 + \sum_{\hat{b}\in\mathcal{B}_b} \delta_{\hat{b},k} \tag{10a}$$

$$\delta_{\hat{b},k} \geq \sum_{i\in\mathcal{U}_{\hat{b}}} |\mathbf{h}_{\hat{b},k}\mathbf{w}_i|^2, \forall k \in \mathcal{U}_b, \forall b \in \mathcal{B}_b \tag{10b}$$

where $\mathcal{B}_b = \{1, 2, \ldots, b-1, b+1, \ldots, N_B\}$ is the set of neighboring BSs for BS b and $\delta_{\hat{b},i}$ is the interference caused from BS $\hat{b}$ to user i. Equation (10b) is a relaxed interference constraint used to favor the distributed implementation.

Even after relaxing the interference terms from the respective neighboring BSs for each of the user k, the problem is still not in the distributed form across the coordinating BSs. Therefore, we now introduce additional BS specific variables that hold the local copies of the interference caused by the neighboring BSs transmissions as

$$\delta_{\hat{b},k}^{b} \geq \sum_{i\in\mathcal{U}_{\hat{b}}} |\mathbf{h}_{\hat{b},k}\mathbf{w}_i|^2, \forall k \in \mathcal{U}_b, \forall \hat{b} \in \mathcal{B}_b \tag{11a}$$

$$\delta_{b,i}^{b} \geq \sum_{j\in\mathcal{U}_b} |\mathbf{h}_{b,i}\mathbf{w}_j|^2, \forall i \in \bar{\mathcal{U}}_b \tag{11b}$$

$$\delta_{\hat{b},k}^{b} = \delta_{\hat{b},k}, \forall k \in \mathcal{U}_b, \forall \hat{b} \in \mathcal{B}_b \tag{11c}$$

$$\delta_{b,i}^{b} = \delta_{b,i}, \forall i \in \mathcal{U}_b \tag{11d}$$

where $\bar{\mathcal{U}}_b = \mathcal{U}\backslash\mathcal{U}_b$, $\delta_{\hat{b},k}^{b}$ denotes the local copy of the total interference caused by BS $\hat{b}$ to user k, which is served by BS b. Similarly, $\delta_{b,i}^{b}$ represents the local copy of the actual interference caused by BS b to user i, which is served by some other BS, say, $\hat{b}$. The constraints in (11c) and (11d) are used to ensure that the local copies of the interference terms maintained at each BS are equal, *i.e.*, it ensures

$$\delta_{\hat{b},k}^{\hat{b}} = \delta_{\hat{b},k}^{b} \tag{12}$$

which relates the actual interference $\delta_{\hat{b},k}^{\hat{b}}$ caused by BS $\hat{b}$ to user $k \in \mathcal{U}_b$ to the one assumed by BS b for user k as $\delta_{\hat{b},k}^{b}$.

The distributed method will be identical to the centralized design if (12) is satisfied at the optimum. To do so, we relax the equality constraint in (12) by including it in the objective of BS b. Now, by grouping the relevant terms, the relaxed objective of BS b, denoted by $\mathcal{A}_b$, is given by

$$\begin{aligned}\mathcal{A}_b(\gamma_k, \delta_{\hat{b},k}^{b}, \delta_{b,i}^{b}, \nu_{\hat{b},k}, \nu_{b,i}) &\triangleq \sum_{k\in\mathcal{U}_b} \alpha_k \log(1+\gamma_k) \\ &+ \sum_{\hat{b}\in\mathcal{B}_b} \sum_{k\in\mathcal{U}_b} \left(\delta_{\hat{b},k}^{b} - \delta_{\hat{b},k}\right) \nu_{\hat{b},k} \\ &+ \sum_{i\in\bar{\mathcal{U}}_b} \delta_{b,i}^{b} - \delta_{b,i} \quad \nu_{b,i}\end{aligned} \tag{13}$$

where $\delta_{\hat{b},k}$ is the global consensus interference to user k from BS $\hat{b}$. The above formulation is known as dual decomposition [17]. For distributed solutions we adopt the ADMM in [19]. Towards this end we consider the augmented objective for each BS b_k given by

$$\begin{aligned}&\bar{\mathcal{A}}_b(\gamma_k, \delta_{\hat{b},k}^{b}, \delta_{b,i}^{b}, \nu_{\hat{b},k}, \nu_{b,i}) \\ &\triangleq \mathcal{A}_b(\gamma_k, \delta_{\hat{b},k}^{b}, \delta_{\hat{b},i}^{b}, \nu_{\hat{b},k}, \nu_{b,i}) \\ &+ \frac{\rho}{2} \sum_{\hat{b}\in\mathcal{B}_b} \sum_{k\in\mathcal{U}_b} \|\delta_{\hat{b},k}^{b} - \delta_{\hat{b},k}\|^2 + \frac{\rho}{2} \sum_{i\in\bar{\mathcal{U}}_b} \|\delta_{b,i}^{b} - \delta_{b,i}\|^2\end{aligned} \tag{14}$$

where the quadratic terms have been introduced. The proximal term $\|\delta_{\hat{b},k}^{b} - \delta_{\hat{b},k}\|^2$ ensures the uniqueness of the final solution and also stabilizes the update expression. Now, by using (14) in (13), we obtain the ADMM based distributed design for each BS b with fixed $\nu_{\hat{b},k}, \nu_{b,i}$ as

$$\begin{aligned} \underset{\substack{\{\mathbf{w}_k\},\{\gamma_k\},\{\beta_k\},\\ \{\delta^b_{\hat{b},k}\},\{\delta^b_{b,i}\}}}{\text{maximize}} \quad & \bar{\mathcal{A}}_b(\gamma_k, \delta^b_{\hat{b},k}, \delta^b_{b,i}) && \text{(15a)}\\ \text{subject to} \quad & \sum_{k\in\mathcal{U}_b} \|\mathbf{w}_k\|_2^2 \leq P_b && \text{(15b)}\\ & \sum_{k\in\mathcal{U}_b} |\mathbf{h}_{b,i}\mathbf{w}_k|^2 \leq \delta^b_{b,i}, \; \forall i \in \bar{\mathcal{U}}_b && \text{(15c)}\\ & \text{(9c), (9b), (9f) and (10a).} && \text{(15d)} \end{aligned}$$

The problem in (15) is solved for fixed dual variable $\nu_{\hat{b},k}$ as $\nu^i_{\hat{b},k}$ and $\delta_{\hat{b},k}$. Upon solving (15) independently across each BS, the coupling variables such as $\delta_{\hat{b},k}$, $\nu^i_{\hat{b},k}$ need to be updated for obtaining the centralized solution. In order to do so, we need to exchange the interference variables $\delta^b_{\hat{b},k}$ and $\delta^{\hat{b}}_{\hat{b},k}$ across the BSs b and $\hat{b}$. Upon obtaining the coupling interference variables, the global consensus variable $\delta_{\hat{b},k}$ is updated at the corresponding BSs $\hat{b}$ and b as

$$\delta_{\hat{b},k} = \frac{\delta^b_{\hat{b},k} + \delta^{\hat{b}}_{\hat{b},k}}{2}. \tag{16}$$

Once the consensus terms are updated, the respective dual variable $\nu_{\hat{b},k}$ of BS b is evaluated by using the following subgradient update as

$$\nu^{i+1}_{\hat{b},k} = \nu^i_{\hat{b},k} - \rho\left(\delta^b_{\hat{b},k} - \delta_{\hat{b},k}\right). \tag{17}$$

The algorithmic representation of the distributed ADMM based precoder design is outlined in Algorithm 1. The total number of variables, *i.e.*, the consensus interference $\delta_{b,k}$, that is exchanged across the coordinating BSs is given by $(N_B - 1) \times K$, since each user will see interference from $N_B - 1$ BSs excluding the serving BS.

Algorithm 1: ADMM Method

Input: $\alpha_k, \mathbf{h}_{b_k,k}, \forall b \in \mathcal{B}, \forall k \in \mathcal{U}_b$.
Output: $\mathbf{w}_k, \forall k \in \{1, 2, \ldots, K\}$
Initialization: $i = 0$ and $\mathbf{w}_k$ by satisfying total transmit power constraint
initialize $\delta^0_{\hat{b},k} = \mathbf{0}^{\mathrm{T}}$ and $\nu^0_{\hat{b},k} = \mathbf{1}^{\mathrm{T}}$
for each BS $b \in \mathcal{B}$ perform the following procedure
repeat
  begin with $j = 0$
  repeat
    solve for $\mathbf{w}_k$ and local interference $\delta^b_{\hat{b},k}$ using (15)
    exchange $\delta^b_{\hat{b},k}$ and $\delta^{\hat{b}}_{\hat{b},k}$ among BSs b and $\hat{b}$
    update the global consensus terms using (16)
    evaluate the dual variables $\nu_{\hat{b},k}$ using (17)
  until do until convergence
  update $\phi^{(i)}_k$ with (7) using the solution from (15)
until perform until SPCA problem convergence

V. Simulation Results

In this section, we analyze the performance of MISO IBC precoder design for various scenarios. Figure 1 illustrates the convergence of the proposed algorithms by distributing the users around the cell-edge. The scenario considered involves $N_{\mathrm{B}} = 2$ BSs, having $N_{\mathrm{T}} = 8$ transmit antennas, operating at 10dB signal-to-noise-ratio (SNR) and serving $K = 2$ single receive antenna users in a coordinated manner. Figure 1 demonstrates the sum rate performance of various algorithms. The sum rate plot is shown only at the SCA update points. Due to limited number of ADMM iterations, we cannot ensure the monotonicity of the sum rate convergence.

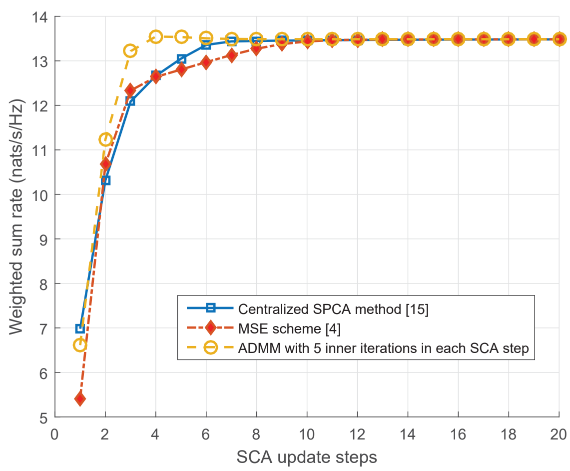

Fig. 1. Sum rate performance for $N_{\mathrm{T}} = 8, N_{\mathrm{B}} = 2, K = 4$ model at 10 dB SNR with users at cell-edge.

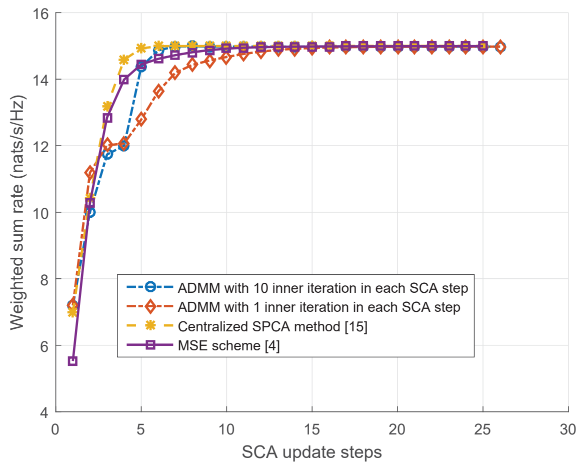

Fig. 2. Sum rate performance for $N_{\mathrm{T}} = 8, N_{\mathrm{B}} = 2, K = 4$ model with pathloss in $[0, -12]$ dB at 10 dB SNR.

Figure 2 demonstrates a scenario with $N_{\mathrm{B}} = 2$ BSs, each equipped with $N_{\mathrm{T}} = 8$ transmit elements operating at 10 dB SNR, serving $K = 4$ single receive antenna users in a

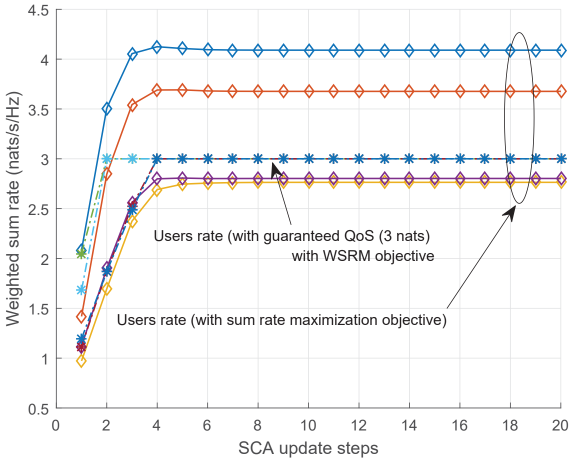

Fig. 3. Behavior of users at 10 dB for ADMM method with and without QoS constraints $N_{\mathrm{T}} = 8, N_{\mathrm{B}} = 2, K = 4$ model.

coordinated manner. The users are assumed to be distributed with signal-to-interference-ratio (SIR) in $[0, 6]$ dB. The performances of the ADMM and centralized precoder designs are shown in Figure 2. The initial values of the precoders are generated based on single user transmit beamformer. The convergence of ADMM need not be monotonic in each update. Even with single ADMM update, *i.e.*, $j = 1$, the sum rate achieved by the proposed distributed method is comparable to the centralized performance. Therefore, by fixing $j = 1$, the backhaul usage can be restricted greatly without compromising on the sum rate performance.

Figure 3 illustrates the performance of the ADMM scheme with and without QoS constraints. The model involves $N_{\mathrm{B}} = 2$ BSs, equipped with $N_{\mathrm{T}} = 8$ transmit elements serving $K = 4$ single antenna users. As seen from Figure 3 that the minimum rate provided for a user is ≈ 2.75 nats with the WSRM objective. However, when we included an additional guaranteed rate constraint of 3 nats to each user, the proposed ADMM based distributed algorithm provided the required QoS of 3 nats to all users as highlighted in Figure 3.

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VII. Conclusion

We addressed the problem of distributed precoder design with the weighted sum rate maximization objective for a multi-user-multiple-input multiple-output transmission. We extended the existing method for finding transmit precoders in a centralized manner to a distributed design by employing alternating directions method of multipliers technique. Additionally, we also considered the problem of providing a guaranteed quality-of-service to all the users and proposed a distributed solution using the alternating directions method of multipliers technique. The suggested decentralized designs require limited signaling overhead compared to the centralized schemes. Numerical results are provided to demonstrate the sum rate behavior and the catering of target quality-of-service requirements of both centralized and distributed schemes.

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