DISTRIBUTED JOINT TRANSMITTER DESIGN AND SELECTION USING AUGMENTED ADMM

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Abstract

- Goal of this work is to design of network in which multiple transmission points(TPs) cooperatively serve users
- TPs jointly precode shared data which aims in improving overall system rate
- TP designs local precoder and reaches consensus with other TPs on leaked interference
- This approach is different as it solves a design problem that involves a coupling constraint which no existing algorithm is able to solve

System Model & Notations

Assume the network consists of a set of TPs. Set of users should be served by subset of TPs, known as the cooperating set.

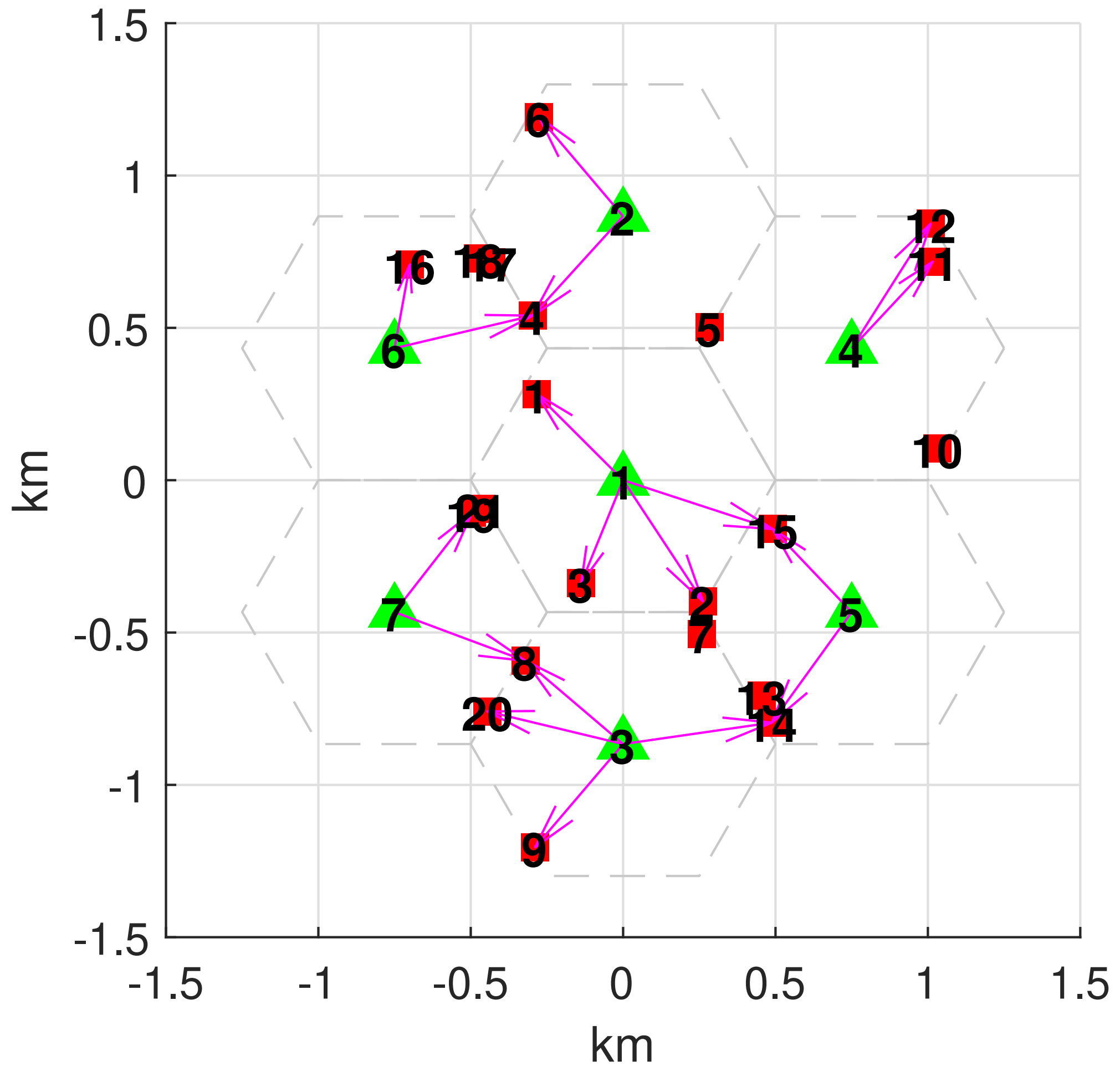

Figure 4: Example of Considered Network

- Indices i, j for UEs, q for TPs
- TPs and UEs have n_T and n_R antennas
- Channel between TP and UE - $\mathbf{H}_i^q \in \mathbb{C}^{n_R \times n_T}$
- Precoder from TP to UE $\mathbf{F}_i^q \in \mathbb{C}^{n_T \times n_{\text{streams}}}$
- Rcv signal $\mathbf{y}_i = \sum_q \mathbf{H}_i^q \mathbf{F}_i^q \mathbf{s}_i + \sum_{j \neq i} \sum_q \mathbf{H}_i^q \mathbf{F}_j^q \mathbf{s}_j + \mathbf{n}_i$

Problem Formulation and Reformulation

The problem formulated maximizing sum received signal power subject to instantaneous leakage interference and the transmit power constraint. TPs activation controlled by adjusting regularization term.

$$\max_{\mathbf{F}_i^q, i\in\mathcal{I}, q\in\mathcal{Q}} \sum\nolimits_q \sum\nolimits_i \|\mathbf{H}_i^q \mathbf{F}_i^q\|^2 - \alpha \|\mathbf{F}_i^q\|_0^2$$

$$s.t. \underbrace{\sum\nolimits_q \|\mathbf{H}_j^q \mathbf{F}_i^q\|^2}_{\text{coupling constraint}} \leq I_{th},\ i,j \in \mathcal{I} : i \neq j \xrightarrow{\mathbf{Q} \triangleq \mathbf{F}\mathbf{F}^H}$$

$$\sum\nolimits_i \|\mathbf{F}_i^q\|^2 \leq P, q \in \mathcal{Q}$$

$$\max_{\mathbf{Q}, \mathbf{Q}_c} \sum\nolimits_i \sum\nolimits_q tr\left(\mathbf{H}_i^q \mathbf{Q}_i^q \mathbf{H}_i^{qH}\right) - \alpha \mathbf{1}_{n_T}^T |\mathbf{Q}_i^q| \mathbf{1}_{n_T}$$

$$s.t. \sum\nolimits_q tr\left(\mathbf{H}_j^q \mathbf{Q}_{c\,i}^q \mathbf{H}_j^{qH}\right) \leq I_{th},\ i \in \mathcal{I} : j \neq i$$

$$\sum\nolimits_i tr\left(\mathbf{Q}_{c\,i}^q\right) \leq P^q,\ \mathbf{Q}_i^q \succeq 0,\ i \in \mathcal{I}, q \in \mathcal{Q}$$

$$\mathbf{Q}_i^q = \mathbf{Q}_{c\,i}^q, i \in \mathcal{I}, q \in \mathcal{Q} \Leftarrow \text{ADMM constraint}$$

Use ADMM to futher problem decomposed in 3:

Local optimization step	**Consensus step**	**Dual ascent step**
Optimize objective wrt primal variable	Find constrainted variable $\mathbf{Q}_c$ close to primal variable	Update dual variable for $\mathbf{Q} = \mathbf{Q}_c$ equality

Simulated Environment

# of TPs/UEs	$Q = 7, K = 21$
# of Antennas	$n_T = 4, n_R = 2$
I_{th}	$10^{-4} W$
P^q	$1W$
σ^2	-33 dB
Ref loss(dB)	60
PL exponent	3.76
Shadowing	10 dB
Tx antenna gain	10 dB

$\rho^{(0)}$	ϵ_{fista}	ϵ_{glo}	μ	τ	$Nrand$	$c^{(n)}$
2	10^{-6}	10^{-6}	1.1	5	10^4	$\frac{10^4}{n+1}$

Proposed Algorithm

Algorithm 1: Distributed consensus optimization using proposed AADMM.

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Result: Precoder matrices $\mathbf{Q}_i^q\ \forall i \in \mathcal{I}, \forall q \in \mathcal{Q}$
0. Initialize: $\mathbf{Q}_s^{q(0)}, \mathbf{Q}_c^{q(0)}, \boldsymbol{\lambda}^{q(0)}, \boldsymbol{\ell}^{q(0)}, \boldsymbol{L}^{q(0)}, m = 0$
while $|r_p^{(m)}| \geq \epsilon_{glo}$ & $|r_d^{(m)}| \geq \epsilon_{glo}$ do
    $m = m + 1$
    1. Local primal step: Set $p = 0$. For each TP
    while $\|\nabla f_1^q(\mathbf{Q}_i^q)\| \leq \epsilon_{fista}$ do
        $p = p + 1$; Compute $\mathbf{Q}_i^{q(p+1)}$)
    2. Consensus optimization step
    Set $n = 0$. For each TP
    while $\|\mathbf{Q}_c^{q(n+1)} - \mathbf{Q}_c^{q(n)}\|_F \leq \epsilon_{cons}$ do
        $n = n + 1$; Update $c^{(n)}$;
        Receive $\boldsymbol{\lambda}^{q(n+1)}$ and update $\boldsymbol{\ell}^{q(n+1)}$
        Update $\mathbf{Q}_c^{q(n+1)}$, $S_{ij}^{q(n+1)}$. Update $\boldsymbol{\lambda}^{q(n+1)}$
        Receive $S_{ij}^{q(n+1)}$ and update $\mathbf{L}^{q(n+1)}$
    3. Dual ascent step: compute $\mathbf{Q}_s^{q^{(m)}}$
    4. Update ADMM parameter: $\rho^{(m+1)}$.
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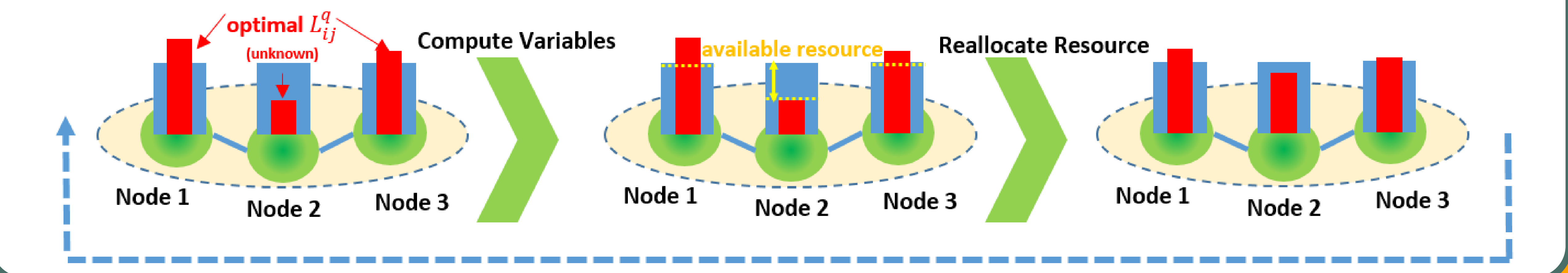
ADMM Augmentation for Coupling Constraint



Numerical Results

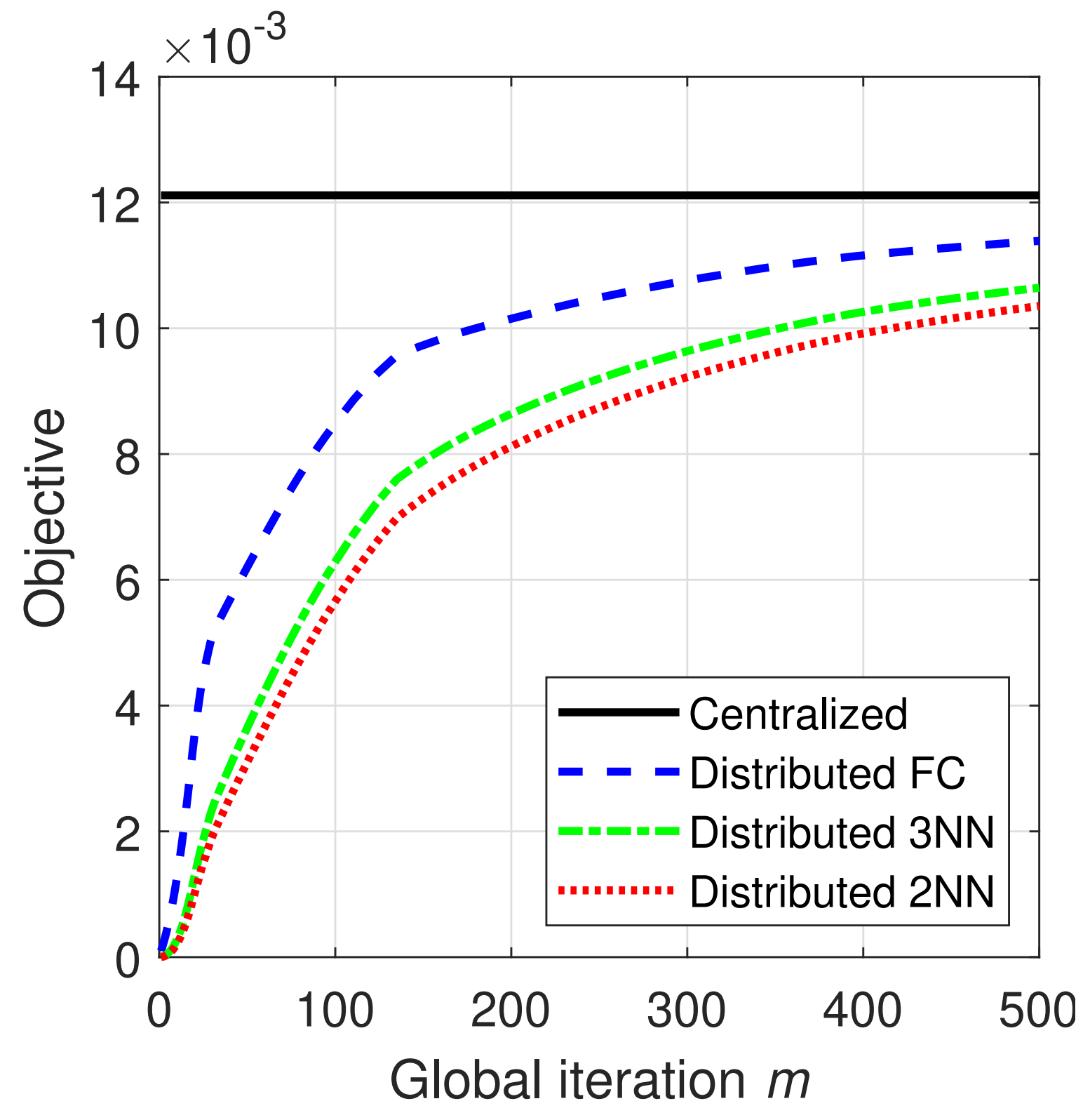


Figure 1: Example of Convergence

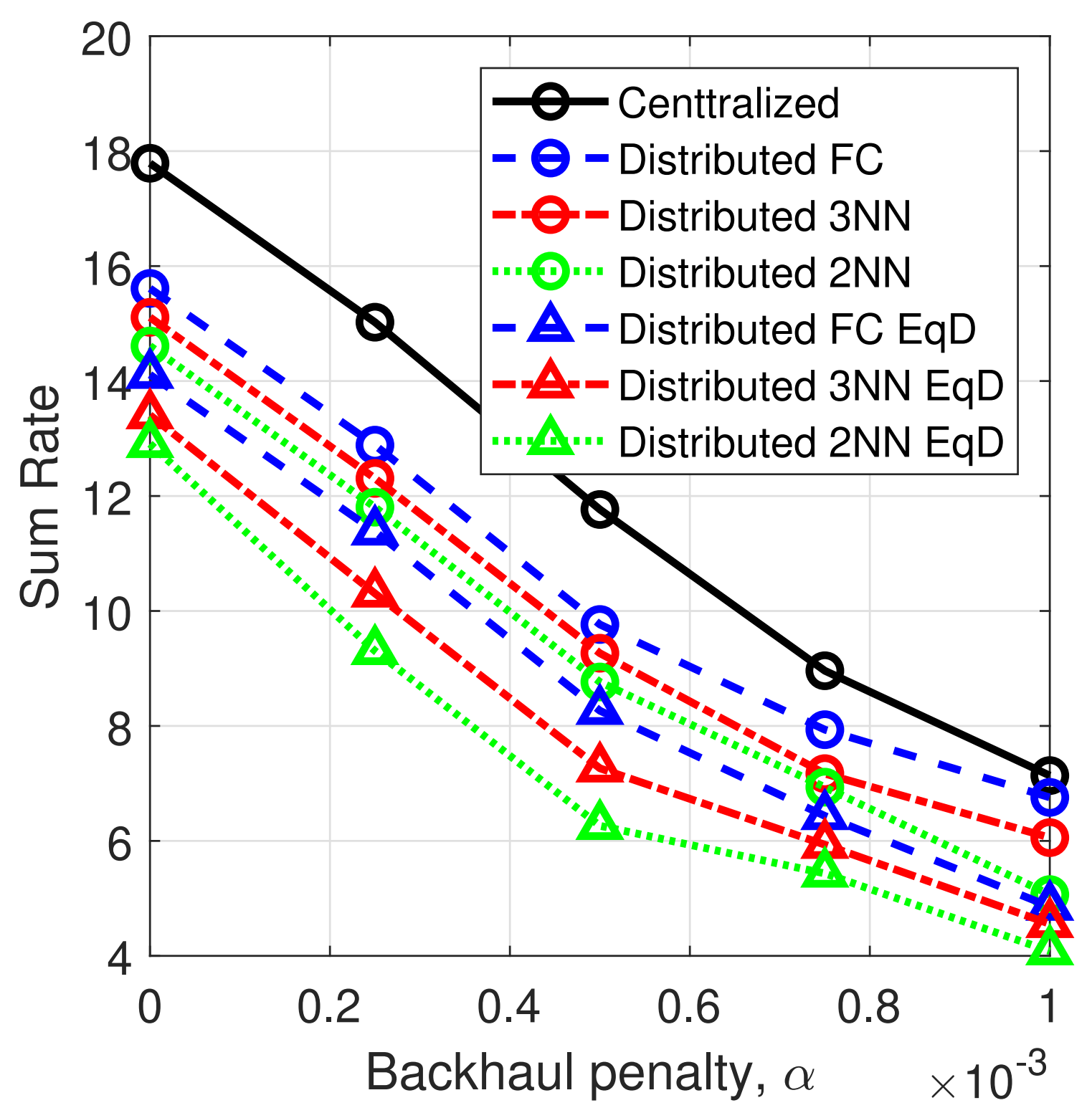


Figure 2: System Sum Rate

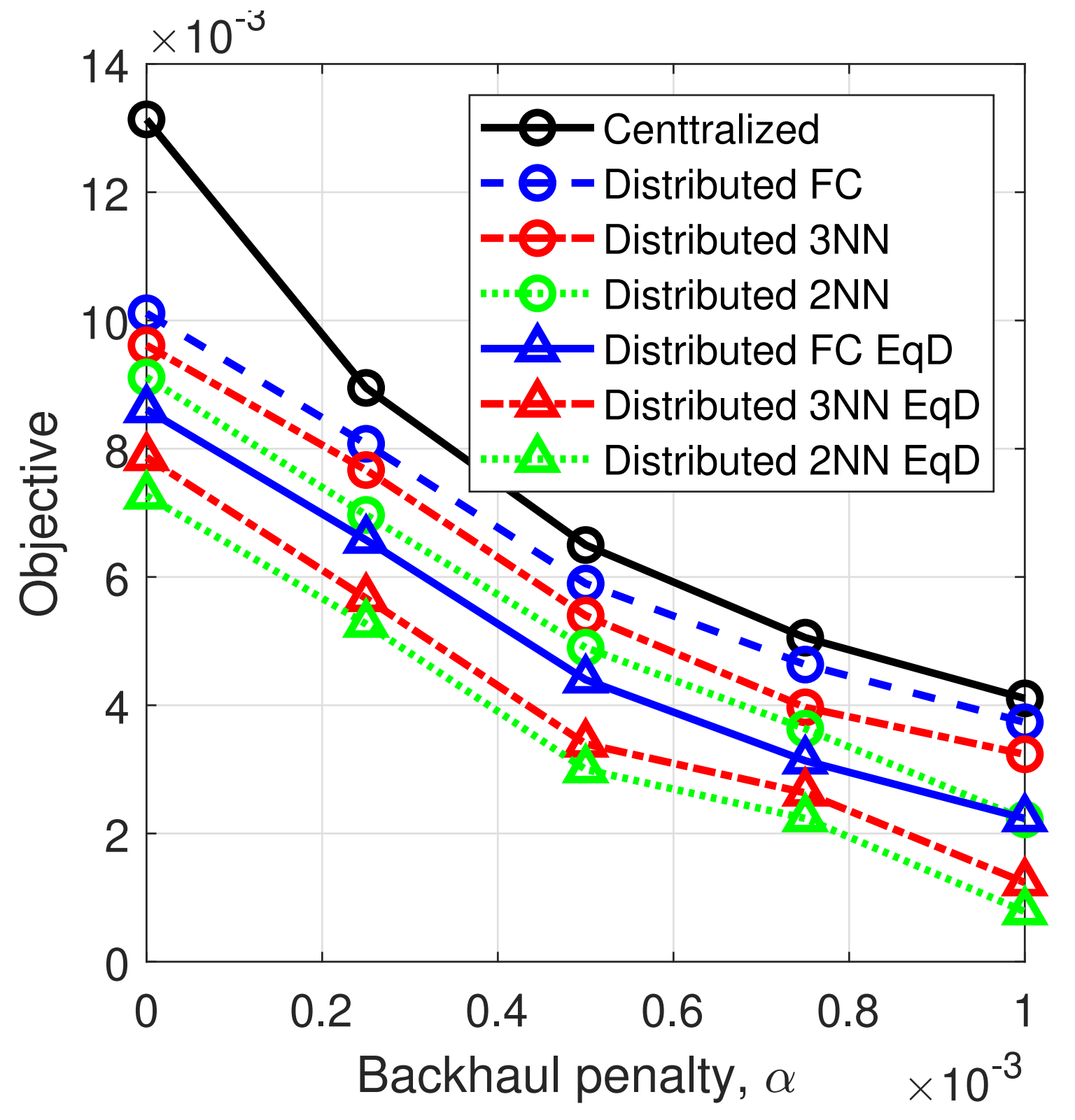


Figure 3: Overall Objective

Key References

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Contact Info&Aknowledgement

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