Optimal Resource Allocation in Downlink of a two cell OFDMA network

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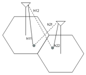
Outline

Background

- resource allocation in OFDMA
  - subcarriers
  - power
- resource allocation in a single cell
  - disjoint resource allocation
  - joint resource allocation [Seong:06]
- multi cell networks
  - inter cell interference limits independent resource allcoation
    - fixed frequency reuse
    - Random frequency reuse [Kiani:06]
  - **we propose joint resource allocation in the network**

Network Model



Network Model

- $K1$ users in cellA and $K2$ users in cellB
- N subcarriers in each cell
- $p_{kn}^{(1)}, p_{jn}^{(2)}$ are powers allocated to user k in cellA and to user j in cellB respectively

Network Model (2)

- $h_{kn}^{(11)}, h_{jn}^{(22)}$ are direct channel gain in cellA and cellB respectively
- $h_{kn}^{(21)}, h_{jn}^{(12)}$ are interference channel gains in cellA and cellB respectively
- $r^{(1))}{}_{(kn)}, r_{jn}^{(2)}$ are rates of user k in cellA and user j in cellB respectively

Problem formulation

- Objective: Maximise sum rate of two cells with power constraints.
  max $\sum_{n=1}^{N}\left(\sum_{k=1}^{K_1} r_{kn}^{(1)} + \sum_{j=1}^{K_2} r_{jn}^{(2)}\right)$
  Subject to
- OFDMA constraints: Each subcarrier is allocated to a single user in a cell $p_{in}^{(1)} p_{jn}^{(1)} = 0 \forall i \neq j$ and also $p_{in}^{(2)} p_{jn}^{(2)} = 0$
- Total power constraints
  - power allocated in cellA is less than the P_{tot}
  - power allocated in cellB is less than the P_{tot}

Application of Lagrage dual theory

- primal objective function
  $\max \sum_{n=1}^{N} \left(\sum_{k=1}^{K_1} r_{kn}^{(1)} + \sum_{j=1}^{K_2} r_{jn}^{(2)} \right)$
- constraints
  - Each subcarrier in a cell should be used by a single user
  - total power allcoated in each cell is less than the P_{tot}
- Construct the Lagrangian with lagrange multipliers
- Dual objective is unconstrained maximum of the Lagrangian is $g(\alpha_1, \alpha_2)$
- Minimise Dual objective $g(\alpha_1, \alpha_2)$ and $\alpha_1 > 0, \alpha_2 > 0$

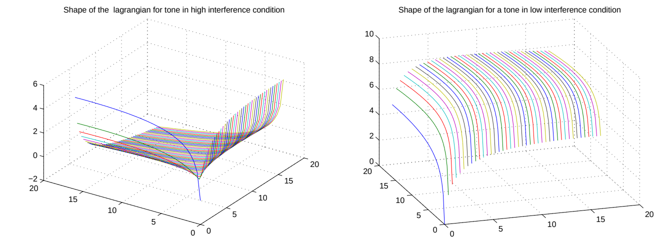
Algorithm

- Initialise α_1, α_2 to large value.
- while ((power consumed in cell1 $<$ total power) and (powerconsumed in cell2 $<$ total power))
  - For all the subcarriers
    - Choose the best user combination among of $K_1 * K_2$
  - end
- Minimise dual objective $g(\alpha_1, \alpha_2)$ with gradient search method.

Simulation setting

- Frequency non selective Rayleigh fading
- K1=2;K2=2;N=8
- Standard deviation of channel coefficients: h11=1;h22=1;h12=0.1;h21=0.1

Profile of the lagrangian for a subcarrier



Comparison of power allocation for different schemes for N=8 and N=16

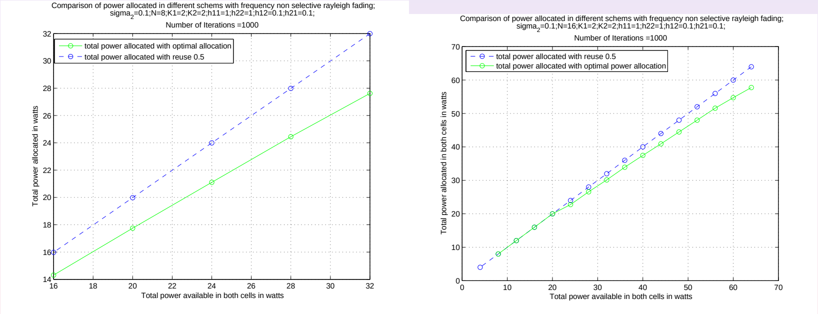
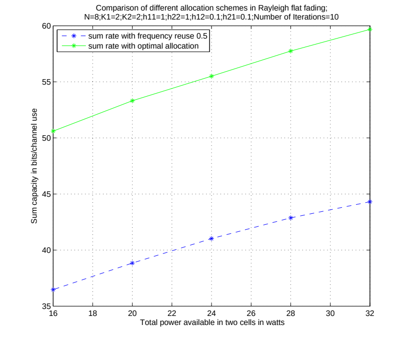


Figure: Comparison of power allocation for different schemes for N=8 and N=16

Numerical Results (3)



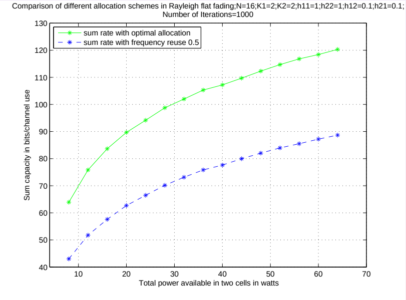


Figure: Comparison of sum rate for different schemes for N=8 and N=16

Numerical Results (4)

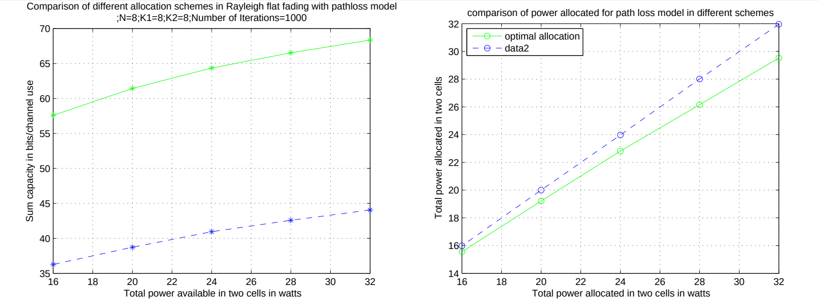


Figure: Comparison of sum rate for different schemes in a pathloss model

Conclusions

- Proposed scheme shows significant gains compared to fixed frequency reuse
- Soft frequency reuse
- Distributed schemes should be explored

- Kibeom Seong, Mehdi Mosheni, and John Cioffi. *Optimal Resource Allocation of OFDMA Downlink Systems,* IEEE International Symposium on Information Theory, Seattle, USA, 2006.
- Anders GjendemsjØ, David Gesbert, GeirØ E.ien, and Saad G. Kiani. Optimal Power Allocation and Scheduling for Two-Cell Capacity Maximization, 2006.
- Saad Kiani, Geir Øien, and David Gesbert. *Maximizing Multicell Capacity Using Distributed Power Allocation and Scheduling,* IEEE WCNC, Hong Kong, China, March 2007.