

Cooperative Multi-Cell Zero-Forcing Beamforming in Cellular Downlink Channels

Oren Somekh*, Osvaldo Simeone[†], Yeheskel Bar-Ness[‡],

Alexander M. Haimovich[†], and Shlomo Shamai (Shitz)[‡]

* Department of Electrical Engineering, Princeton University, Princeton,
NJ 08544, USA, Email: orens@princeton.edu

[†] Department of Electrical and Computer Engineering, NJIT, Newark,
NJ 07102, USA, Email: {simeone, haimovich, barness}@njit.edu

[‡] Department of Electrical Engineering, Technion, Haifa 32000, Israel,
Email: sshlomo@ee.technion.ac.il

Abstract

For a multiple-input single-output (MISO) downlink channel with M transmit antennas, it has been recently proved that zero-forcing beamforming (ZFBF) to a subset of (at most) M “semi-orthogonal” users is optimal in terms of sum-rate, asymptotically with the number of users. However, determining the subset of users for transmission is a complex optimization problem. Adopting the ZFBF scheme in a cooperative multi-cell scenario renders the selection process even more difficult since more users are likely to be involved. In this paper, we consider a multi-cell cooperative ZFBF scheme combined with a simple sub-optimal users selection procedure for the Wyner downlink channel setup. According to this sub-optimal procedure, the user with the “best” local channel is selected for transmission in each cell. The performance of this sub-optimal scheme is investigated in terms of both, the conventional scaling law of the sum-rate with the number of users, and a sum-rate offset. We term this characterization of the sum-rate for large number of users as *high-load regime* characterization, and point out the similarity of this approach with the standard affine approximation used in the high-SNR regime. It is shown that under an overall power constraint, the sub-optimal cooperative multi-cell ZFBF scheme achieves the same sum-rate growth rate and slightly degraded offset law, when compared to an optimal scheme deploying joint multi-cell dirty-paper coding (DPC) techniques, asymptotically with the number of users