

Robust Transmission and Interference Management for Femtocells with Unreliable Network Access

O. Simeone¹, E. Erkip² and S. Shamai (Shitz)³

¹CWCSPR, Dept. of ECE, NJIT, Newark, NJ, USA

²Dept. of ECE, Polytechnic Inst. of NYU, Brooklyn, New York, NY, USA

³Dept. of Electrical Engineering, Technion, Haifa, Israel

Abstract

A cellular system where macrocells are overlaid with femtocells is studied. Each femtocell is served by a home base station (HBS) that is connected to the macrocell base station (BS) via an unreliable network access link, such as DSL followed by the Internet. A scenario with a single macrocell and a single femtocell is studied first, and is then extended to include multiple macrocells and femtocells, both with standard single-cell processing and with multicell processing (or network MIMO). Two main issues are addressed for the uplink channel: (i) Interference management between femto and macrocells; (ii) Robustness to uncertainties on the quality of the femtocell (HBS to BS) access link. Closed and open-access femtocells are considered, along with robust variable-rate data delivery transmission at the home users via the broadcast coding approach (or unequal error protection coding). The problem is formulated in information-theoretic terms, and inner and outer bounds are derived to achievable per-cell sum-rates for outdoor and home users. Expected sum-rates with respect to the distribution of the femtocells access link states are studied as well. Overall, the analysis lends evidence to the performance advantages of sophisticated interference management techniques, based on joint decoding and relaying, and of robust coding strategies via the broadcast coding approach.