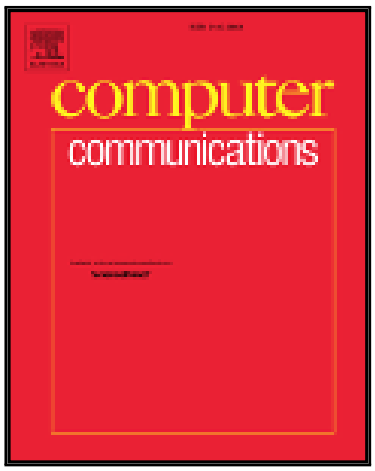

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Analytical Evaluation of Heterogeneous Cellular Networks Under Flexible User Association and Frequency Reuse

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Abstract

Offloading mobile users from highly loaded macro base stations (BSs) to lightly-loaded small cell BSs is critical for utilizing the full potential of heterogeneous cellular networks (HCNs). However, to alleviate the signal-to-interference-plus-noise ratio (SINR) degradation of so called biased users, offloading needs to be activated in conjunction with an efficient interference management mechanism. Fractional frequency reuse (FFR) is an attractive interference management technique due to its bandwidth efficiency and its suitability to orthogonal frequency division multiple access based cellular networks. This paper introduces a general mathematical model to study the potential benefit of load balancing in conjunction with two main types of FFR interference coordination: Strict-FFR and soft frequency reuse (SFR)- in the downlink transmissions of HCNs. For some special but realistic cases we were able to reduce the rather complex general mathematical expressions to much simpler closed-forms that reveal the basic properties of BS density on the overall coverage probability. We show that although Strict-FFR outperforms the SFR mechanism in terms of SINR and rate coverage probability, it fails to provide the same spectral efficiency. Finally, we present a novel resource allocation mechanism based on the BSs bias values and FFR thresholds that achieves an even higher minimum user throughput and rate coverage probability.

Index Terms

Heterogeneous cellular networks, Poisson point processes, frequency reuse, user association.

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