Coverage Analysis of Packet Multi-Tier Networks With Asynchronous Slots

Abstract:

Using stochastic geometry, the downlink (DL) and uplink (UL) coverage probabilities are derived for co-channel packet multi-tier heterogeneous cellular networks (HCNs). The spatial locations of base stations (BSs) as well as user equipments (UEs) are modeled as independent spatial homogeneous Poisson point processes. The decoupled association is evaluated where the UE may connect to different BSs in the UL and DL transmissions. Unlike most of the existing works, the packet transmission slots are not synchronized, that is, the starting and ending points of the slots are not aligned. We investigate fundamental performance metrics of dynamic packet HCN for two traffic models, namely, the slotted-asynchronous and exponential-interarrival. Furthermore, tight lower bounds for the DL and UL coverage probabilities for two traffic models are obtained. The derived bounds are tight especially in high data rate regimes. The analysis provided herein enables us to determine the performance limits of packet-based HCNs with possible asynchronous time-slots. Simulation results are conducted to verify the analytical derivations. Furthermore, the performance comparison between pure synchronous and asynchronous packet-based systems is provided. The results confirm that the synchronous case outperforms the asynchronous one in terms of the UL and DL coverage probabilities at the cost of higher computational complexity.