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On the Capacity of Downlink Multi-hop Heterogeneous Cellular Networks

Abstract:

Multi-hop heterogeneous cellular networks (MHCNs) consist of conventional macro cellular networks overlaid with an irregular deployment of low-power base stations (BSs), where the communication between BSs and mobile users can be established through a single hop or multiple hops. By modeling different kinds of randomly located BSs as K tiers of independent homogeneous Poisson Point Processes, we first explore the capacity of downlink MHCNs and derive the expression of capacity under Rayleigh fading channels. Particularly, the capacity gain achieved by cell splitting and multi-hop relaying is quantified for the first time. We then study the effects of BS density, transmit power, and signal-tointerference- plus-noise-ratio (SINR) threshold on the capacity of MHCNs. More importantly, we obtain the spectral efficiency enhancement condition under which the increase of BS density and transmit power improve the spectral efficiency, thereby enhancing the capacity. One interesting observation is that at a given SINR threshold, the capacity increases with BS density when all the tiers have the same SINR threshold. Moreover, the capacity of some special networks (i.e. heterogeneous cellular networks, multi-hop cellular networks, and conventional cellular networks) are derived directly by specializing some system parameters in our results. Finally, numerical studies and simulations are conducted to validate our analysis.