Abstract

To reinforce the bandwidth demand which is expanding many folds every year, the cellular operators are deploying small cells alongside cellular network. The spatially deployed base stations (BSs) of different types like macro, pico, femto, etc. (varying in their transmission power), form multiple tiers of wireless networks. The macro base stations (MBSs) are deployed in agreement with demand of low data rate services (like voice) that is often independent from one geographical region to another. However, the small base stations like femto access points (FAPs) are plugged into the network on ad-hoc basis to support high data rate services, like video streaming. Thus, the spatial heterogeneity in the BSs' locations of tiers of such heterogeneous networks (HetNets) is certain. For performance analysis, we model the tiers of HetNet using tools of stochastic geometry like Poisson point process (PPP), which is recently validated and well adopted by the researchers community.

In cellular, the coverage probability and activity factor (load dependent parameter) are coupled with each other through interference. In the first work, while exploiting this coupling, we present an approach for the evaluation of blocking probability for PPP modeled cellular network. It is observed that the presented approach tracks the blocking probability accurately in its lower value. Further, an interesting trend is seen that decreasing the number of channels and increasing the BS density (or, vice versa) by a same factor yields same blocking probability. Extending the developed approach, we derive the coverage and blocking probability of cell center/edge (CCU/CEU) in two-tier HetNet in the second part of the work. The derived expressions of coverage probability are validated through simulation results. It is shown that a properly configured shared spectrum allocation (SSA) can yield fair grade of service along with improved coverage as compared to co-channel spectrum allocation (CSA).

We consider composite modeling of MBSs using PPP and FAPs using Poison cluster process (PCP) to accommodate the fact of cluster formation of FAPs as observed in offices, apartments, malls, etc., in our next part of work. Further, the opportunistic spectrum access is assumed for FAPs to control the inter-tier interference to macro users. The coverage probabilities of macro and femto users are derived and validated through simulation results. It is shown that the orthogonal spectrum allocation (OSA) yields better coverage at higher femto cluster density compared to CSA and SSA. However, there exist a crossover point which is found to be load dependent. Furthermore, we also demonstrate that the reservation of a few number of channels with larger exclusion range for FAPs can improve the coverage of macro users significantly.

In the last part of our work, we attempt to model the scenario of BS-centric clustered users using Thomas cluster process (TCP) to reflect the correlation between users' and MBSs' locations. The coverage probability derived under this model is validated through simulation. It is observed that as the variance of TCP tends to infinity, the coverage under this model becomes same as under the assumption when locations of users and MBSs are independent.

Key words: Heterogeneous network (HetNet), Coverage probability, Blocking probability, Activity factor, Average rate, Macro tier, Femto tier, Macro base station (MBS), Femto access point (FAP), Traffic load, Poisson point process (PPP), Poisson cluster process (PCP), Stochastic geometry, Base station density, User density, Co-channel spectrum

allocation (CSA), Orthogonal spectrum allocation (OSA), Shared spectrum allocation (SSA), etc.