Abstract

Device-to-device (D2D) communication which involves direct communication between the cellular users in proximity, thus bypassing the network infrastructure, i.e., the base station (BS) is envisaged to be an important part of the fifth generation communication network. In this thesis, we analyze the downlink performance of a D2D-enabled cellular communication network with the D2D communication links assumed to be under Nakagami-\(m\) fading, using the tools from stochastic geometry, in terms of the coverage probability. The coverage analysis is presented with the devices placed randomly according to Poisson point process (PPP) for the dedicated scenario, wherein, the frequency resources are allocated separately for both the D2D and the cellular users, and for the shared scenario, wherein, the frequency resources are shared between the D2D and the cellular users. The coverage analysis is further extended to include the case of dense cellular networks for both the dedicated and the shared communication scenarios.

Although, most of the performance analysis of D2D communication systems is studied assuming the device locations to be PPP distributed due to the advantages of tractability of the analysis, the PPP modeling has limitations in providing the complete network description. Also, the PPP modeling of devices does not capture the non-homogeneity in the device location which is effectively modeled by the Poisson cluster process (PCP) and is more close to the depiction of the practical wireless heterogeneous networks. To account for the spatial correlation between the devices, we provide the coverage and the interference analysis of the D2D links assuming the device locations to be distributed as PCPs which is realistic but more complex in comparison to the PPP device modeling. We derive the intra and the inter cluster Laplace transforms
and using them we further derive approximate closed-form expressions for the coverage probability with devices modeled as PCPs for the dedicated network scenario. We also derive the closed-form coverage expressions for the special case of Rayleigh fading. We also show the dependence of the coverage probability on various system parameters.

We provide a useful addition to the available stochastic geometry toolbox for the D2D coverage analysis by giving an alternate way to compute the coverage probability using the interference functional approach. Further, the interference functional approach is compared with the commonly used Laplace transform approach and we observe that both the approaches show similar coverage behavior. The interference functional approach provides the additional advantage of less complexity in the numerical and analytical computation. Additionally, we also provide a bound on the coverage probability using the Alzer’s inequality which is helpful in the coverage calculations for higher fading parameter values.

Relaying in wireless networks is an effective way to reduce fading and increasing the coverage range. We study the performance analysis of a cooperative D2D network with downlink non-orthogonal multiple access and fixed gain amplify-and-forward relaying considering that a direct link exists between the D2D user and the BS. We derive novel closed-form expressions of the outage probability and the system throughput for the D2D users considering a general framework of Nakagami-$m$ fading.