ABSTRACT

The conventional user equipment (UE) association method involves selection of the base station (BS) providing maximum downlink received signal strength. This criteria is incapable of accommodating the need for improving uplink performance when providing 5G uplink connectivity, particularly for applications requiring very short time-to-content and high uplink data rate. Future densification of network will further enhance this uplink-downlink coverage disparity. Downlink Uplink Decoupled (DUDe) has been proposed as a possible strategy to cater for this problem which includes the decoupling of uplink and downlink connectivity. For the sake of reducing complexity and obtaining a tractable model for analyzing the performance of DUDe based networks, same pathloss exponent (PLE) is commonly assumed in the literature for all BSs, irrespective of their tiers. Such an assumption is not practical as the signals from BSs of different tiers are more likely to suffer different rates of pathloss. Moreover, it has been identified that for modeling pathloss for ultra-dense networks (UDNs), the conventional distance-dependent pathloss model (PLM) will not be accurate enough to analyze network performance and may lead to erroneous results. More realistic PLMs, like the multi-slope (MS) PLM is hence recommended when analytically modeling UDNs as the model more accurately incorporates the physical environment around the BS. To the best of our knowledge, DUDe based dense heterogeneous cellular networks (HetNets) have not yet been analyzed using model other than conventional PLM.

This project focuses on analytical modeling of decoupled HetNets using varying PLMs to evaluate its performance metrics. The results obtained from the analysis are drastically different from the ones obtained using the conventional PLM and can be considered more representative of realistic conditions. The project has been carried out in two parts: firstly, a more generalized PLM, with different PLEs assigned to different tiers has been used for analysis. The analysis shows that unlike in previous literature, the DUDe technique performs suboptimal for cases where the environment between the UE and Macro BS (MBS) and that of the UE and the Small BS (SBS) is not similar. The findings highlight a key limitation of applying DUDe technique in realistic conditions where the PLEs of cellular tiers are not exactly equal to one another and motivate further research in varying PLEs environment. Secondly, MS PLM has been used in the uplink performance analysis of dense DUDe based HetNet. Using this model, generalized expressions of network performance indicators have been derived. The results highlight that the uplink coverage probability obtained at higher SBS densities (dense deployment)

using MS PLM is greater than that obtained by single-slope PLM. Also the difference of uplink spectral efficiency obtained through the above-mentioned models increase drastically as the network densifies. The analysis shows that the common assumption of using conventional Single-Slope PLM (SS PLM) oversimplifies the calculation giving impractical results. For more realistic results it is important to use practical PLMs to present the varying pathloss environment.