ABSTRACT

The rapid growth of User Equipment (UE) in the digital era has driven a significant increase in mobile network capacity requirements. This increase poses a major challenge to service quality, particularly due to increased interference in densely populated areas. Therefore, a more optimal network load management strategy is needed to maintain efficiency and service quality. High power consumption, uneven user distribution, and inefficient use of frequency spectrum can impact the performance of Heterogeneous Networks (HetNets).

This study proposes a solution to the challenge of resource allocation in HetNet networks by integrating one Macro Base Station (MBS) and three Small Base Stations (SBS), as well as a number of macrocell users (MUE) and smallcell users (SUE) that are positioned systematically. The system model employs a downlink communication scheme, where resource block (RB) allocation is performed centrally at the MBS and each SBS. The RB allocation process involves the application of greedy, auction, and Gale-Shapley algorithms for user pairing in a 5G network. System performance evaluation is based on metrics including average data rate, sum rate, spectral efficiency, power efficiency, fairness, and outage probability.

Test results show that the Greedy User Pairing method with a user increase scenario in the 5G system demonstrates the best performance, achieving an average data rate of $5{,}206 \times 10^8$ bps and a total sum rate of $5{,}675 \times 10^{10}$ bps, a spectral efficiency value of 26,033 bps/Hz, and a power efficiency of $8{,}521 \times 10^7$bps/W. The Auction User Pairing method also showed good performance with an average data rate of $5{,}192 \times 10^8$ bps and a total sum rate of $5{,}659 \times 10^{10}$ bps. In the 4G system, the Auction method showed fairly good performance, with an average data rate of $1{,}47 \times 10^8$ bps and a total sum rate of $3{,}67 \times 10^9$ bps. The Greedy method in the 4G system cannot compete with other algorithms, yielding an average data rate of $8,76 \times 10^7$ bps and a total sum rate of $3{,}67 \times 10^8$ bps. Finally, in the combined 4G+5G system, the best performance was achieved using the Auction (4G) + Auction (5G) pairing method, reaching an average data rate of $4{,}509 \times 10^8$ bps and a total sum rate of $6{,}042 \times 10^{10}$ bps. The combination of Greedy (4G) + Greedy (5G) pairing has the lowest performance. Overall, this study proves the effectiveness of the Auction and User Pairing algorithms as superior approaches in optimizing network performance.

Keywords: Greedy Algorithm, Auction Algorithm, Gale Shapley Algorithm, HetNet, Resource Block.