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ORIGINAL PAPER

Joint call admission control and load-balancing in ultra-dense cellular networks: a proactive approach

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Abstract

Cellular networks adopt call admission control (CAC) algorithms to prevent network congestion and guarantee quality of service (QoS) for user equipments (UEs). Conventional CAC algorithms accept or reject incoming calls based on radio resource availability. Those rejected calls may lead to network performance degradation. Collaboration of CAC and load-balancing can overcome such a problem. However, conventional joint schemes are reactive and proven time consuming; hence, inefficient in real-world scenarios. To overcome such problems as well as to improve network performance, we propose a proactive approach for joint call admission control and load balancing. The algorithm mitigates the number of rejected calls by performing proactive offloading. To that end, the algorithm identifies potential incoming UEs in a cell prior to handover. If a cell is fully occupied and an incoming UE is detected, the proposed algorithm hands over some of the edge UEs from that particular cell to its neighboring cells. As a result, the cell has enough resources to accept the incoming call. Simulation results show that the proposed algorithm reduces the number of unsatisfied UEs and maximizes network throughput by 11.04%, compared to a network without a CAC algorithm.

Keywords Ultra-dense cellular network · Call admission control · Load-balancing · User equipment · Radio resources · Quality of service · Throughput

1 Introduction

The fifth generation (5G) wireless access technology is deployed with the vision of higher data rates, lower latency, and more capacity [1]. The visions for 5G are driven by predictions of up to 1000 times the data requirements and by the emergence of the Internet of Things. To achieve these visions for 5G, the next generation network intends to be a highly dense heterogeneous network [2] [3]. The main idea of such heterogeneous networks is to overlay low-power and low-cost devices on coverage holes or capacity demanding hotspots to supplement conventional single-tier cellular networks. While large cells, covered by macro cells, for example, provide blanket coverage and seamless mobility, small cells served by devices like femto access points, picocells, and relay stations help provide coverage extension and boost local capacity [4]. Therefore, macro and small cells can save user equipments (UEs) according to their requirements. Hence, small cells are now considered an integral part of future ultra-dense networks. Small cells are densifying rapidly in present-day cellular networks [5].

Small cells can cover a very limited area and are vulnerable to UE mobility due to the low transmission power. Also, small cells are given higher preference during the cell selection/reselection, which may lead to an unbalanced traffic load situation in cellular networks. In addition, requested data traffic in cells fluctuates over time and space. Such randomness in the small cell networks brings network congestion frequently. A congestion occurs when the data rate requested by UEs exceeds network capacity, which results in quality of service (QoS) degradation due to improper services. Therefore, cellular networks adopt call admission control (CAC) algorithms to overcome the network congestion problem and secure QoS for the UEs [6]. The CAC refers

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