Optimizations in Heterogeneous Mobile Networks

Heterogeneous Mobile Networks bring advantages over homogeneous deployments in achieving the demand for mobile network capacity and coverage not just outdoor rural and urban areas, but also to homes and enterprises where the large portion of the mobile traffic is generated. However, the heterogeneity in the mobile networks bring many challenges that are discussed in this dissertation. More focus is placed on specific issues with indifferent areas of heterogeneity by proposing optimizations in order to overcome the considered problems. The heterogeneity of mobile networks, together with the densification of the base stations, bring into a very complex network management and operation control for the mobile operators. Furthermore, the need to provide always best connection and service with high quality demands for a joint overall network resource management. This thesis addresses this challenge by proposing a universal hierarchical framework that enables flexible and effective management of diverse resources, namely spectral, optical and computational. Dual Connectivity (DC) is an emerging architecture, which allows for simplified and flexible mobility management and enhanced load balancing among nodes. The independent control of the user’s transmit power at each node may cause degradation of the overall performance. In this line, a dedicated study of power distribution among the carriers is performed. An optimization of the power allocation is proposed and evaluated. The results show significant performance improvement to the achieved user throughput in low as well as in high loads in the cell. The flow control of the data between the nodes is another challenge for effective aggregation of the resources in case of dual connectivity. As such, this thesis discusses the challenges in providing efficient flow control, and investigates an optimal traffic rate allocation method. Cloud Radio Access Network (C-RAN) designates a leading technology for the Radio Access Network (RAN) architecture that is able to support dense deployments, while ensuring network level energy and cost efficiency for the operator. This thesis thoroughly investigates the achievable multiplexing gains under C-RAN through a mathematical model based on the teletraffic theory. The work allows for evaluation of the key parameters and conditions for optimized cell deployment. The model can be applied to dynamically re-assign cells to a pool of baseband units. Furthermore, an evaluation of the various functional splits in the baseband processing is introduced. The proposed mathematical model quantifies the multiplexing gains and the trade-offs between centralization and decentralization concerning the cost of the pool, fronthaul network capacity and resource utilization. Among the benefits that C-RAN brings is the possibility for sharing of the radio spectrum and the resources required for baseband processing among operators. This thesis investigates strategies for active sharing of radio access among multiple operators and analyses the individual benefits depending on the sharing degree.