The introduction of D2D connectivity in cellular networks is a successful approach to meet the increasing demand of device applications and to enhance next-generation networks. Through direct communication between mobile devices using Wi-Fi Direct, many improvements can be achieved to the network. Direct communication allows BS to be offloaded, performance and network coverage to be enhanced, and more efficient power and spectral management.

In this thesis, we examined the challenges integrated in D2D communication by developing the appropriate radio resource management approaches. Our key contributions were in the mode selection, power and frequency allocation techniques. On the other side, we proved that optimizing resource allocations could lead to a great enhancement to D2D communication. Further improvements can be done by integrating more techniques such as, relaying and DL.

We addressed SBRRA approach, an efficient RB allocation for D2D communication to guarantee QoE and QoS. In order to increase the system performance and the capacity at the BS, three-sector cell was introduced with substantial offloading at the BS. Depending on the distance between devices, the D2D pair formation happens. The appropriate cellular reuse partner is chosen for every D2D pair. The D2D pairs are then assigned with an optimum number of RBs, based on the used applications. The SBRRA achieves higher MOS and throughput due to RB reuse in multiple iterations. The sector solution leads to minimizing cell network interference and increasing system performance. For future work, the SBRRA proposed approach can be extended in 5G network. Also, power consumption can be improved by this approach making 5G more energy efficient.

On the other hand, we introduced a DL approach to solve the problem of channel and power allocation. The results in simulation indicate that with higher data samples and hidden layers, the accuracy of the prediction increases. Nevertheless, the increase of the number of hidden layers will not enhance the accuracy and the training model begin to learn irrelevant features. A major challenge lies in ensuring the optimal performance of the DL network, including the corresponding number of hidden layers and data sample size. Finally, DL scenarios training on a massive number of connections and wireless channel variation would be the optimal approach. As a future work, supervised deep learning can be integrated into the cloud and used in a Software Defined Network (SDN) for a faster calculation and less load on the local devices and BS.

Wi-Fi Direct application and MATLAB algorithm has been developed for the benchmarking. The simulation results show that the throughput can be significantly increased, while using Wi-Fi Direct in D2D communication. Also, less power is consumed because Wi-Fi Direct approach can reduce the distance travelled by the signal transmitted. Moreover, as mentioned in chapter 1, Wi-Fi Direct application help us to share emerging information happening near us such as, earthquake, infrastructure failure and accidents. As a future work,

testing the new generation of Wi-Fi Direct and implementing the SBRRA in the application proposed will meaningfully improve the system performance.