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The discrete Fourier transform (DFT) precoding is able to reduce the peak-to-average power ratio (PAPR) of OFDMA (orthogonal frequency-division multiple access) waveforms without requiring any additional signaling overhead. This technique, combined with various sub-carrier allocation methods, has been proposed for uplink transmission in future wideband wireless communication systems, such as the 3GPP UMTS Long Term Evolution (LTE) and the European Union 4G project WINNER.

This thesis focuses on the uplink resource allocation problem in the framework of DFT-precoded OFDMA systems, where adaptive resource assignment according to the channel conditions to optimize the system performance is considered. Specific aspects of high-performance, cost-effective practical solutions are investigated. Different settings regarding the number of available antennas at the transmitter and the receiver are discussed.

At the beginning, we propose a new structure which associates multiple DFT-precodings with a single user equipment (UE) to overcome the limitations in conventional DFT-precoded OFDMA. The proposed structure allows a more flexible use of the frequency resources in the system and enables multiple services for users with different quality of service and error protection requirements. We study both the PAPR and the achievable spectral efficiency for different transmitter structures in LTE uplink scenarios. Additionally, we show potential performance improvements by applying spectrum shaping for the cell-edge UEs.

We further focus on the achievable rate for a DFT-precoded OFDMA uplink system with linear equalization subject to individual power constraints of the UEs. Starting with the single user single-input single-output (SU-SISO) system, we derive a general framework for calculating the achievable sum rate for any arbitrary assignment of the sub-carriers. Based on this, we design an optimal sub-carrier allocation algorithm to maximize the system sum rate. Furthermore, a geometrical interpretation of the above rate optimization problem is provided, along with showing the relationship to the capacity achieving waterfilling solution. Using the derived framework, the sum rates achieved by different sub-carrier and power allocation methods are compared and discussed. The results derived for the SU-SISO case are extended to the SU-SIMO case, where multiple antennas are available at the base station (BS). For the case where multiple antennas are available at both the UE and the BS (SU-MIMO), the achievable rate is also formulated and discussed.

Based on results obtained from the SU-SISO case, the achievable system sum rate in the multi-user (MU-SISO) case is also considered. We develop a heuristic approach for sub-carrier allocation which shows very close performance to the multi-user channel capacity. Furthermore, we propose a channel-dependent, resource fair, score-based scheduler to adaptively assign sub-carriers for UEs. A significant gain is observed compared to other non-adaptive sub-carrier assignment methods. For the case where multiple antennas are available at the BS (MU-SIMO), we further discuss and analyze the achievable rate performance using different transmission strategies including frequency-division multiple access (FDMA), space-division multiple access (SDMA) and a combination of both.

For the case that multiple antennas are available at both the BS and the UEs (MU-MIMO), we develop a joint multi-user precoder optimization algorithm to maximize the system spectral efficiency. Depending on the requirements, at least one of the UEs can maintain the low PAPR property of the single carrier transmit waveform. Additionally, the required feedback overhead to convey the precoder decision to the UE is significantly reduced. Weighted sum rate maximization is also incorporated in the algorithm and its achievable rate region is presented and compared to the rates achieved by other popular precoding schemes for LTE uplink scenarios.