Abstract

This thesis concentrates on joint optimization of transmit power allocation and receive filtering in multiuser, multi-antenna communications. Due to the increasing number of wireless devices, the design of energy-efficient communication links is becoming increasingly important. In cellular mobile communications, reducing the average power consumption in uplink transmission is beneficial for users in order to extend battery life and, hence, energy efficiency in general. However, the power consumption of the high power amplifier (HPA) at the transmitter depends on the peak power of the transmission. This thesis focuses on power allocation problems for single-carrier (SC) frequency division multiple access (FDMA) and orthogonal FDMA (OFDMA) transmission assuming iterative reception.

The goal in the first scheme presented in this thesis is to reduce the average power consumption by designing a power allocation method that takes into account the convergence properties of an iterative receiver in multiuser uplink communications. The proposed scheme can guarantee that the desired quality of service (QoS) is achieved after a sufficient number of iterations.

Reducing the peak-to-average power ratio (PAPR) in any transmission system is beneficial because it allows the use of inexpensive, energy-efficient power amplifiers. The goal in the second scheme presented in this thesis is to control the PAPR of the transmitted signal. Hence, in addition to the QoS constraint, the instantaneous PAPR constraint is derived for SC-FDMA and OFDMA transmission. Moreover, a statistical approach is considered in which the power variance of the transmitted waveform is controlled. The QoS and PAPR constraints are considered jointly and, therefore, the proposed power allocation strategy jointly takes into account the channel quality and the PAPR characteristics of the power amplifier. However, the PAPR constraint can be adopted to any SC-FDMA or OFDMA framework and it is not restricted to the scheme presented in this thesis. The objective of the optimization problems considered throughout the thesis is to minimize the sum power. The majority of the derived constraints are non-convex and therefore, two alternative successive convex approximations (SCAs) are derived for all the non-convex constraints considered.

The numerical results show that the proposed power allocation strategies can significantly reduce the average transmission power of users while allowing flexible PAPR

control. Hence, the proposed methods can be used to extend battery life for users and especially improve the QoS at the cell edges.

Keywords: Power minimization, soft interference cancellation, MMSE receiver, multiuser detection, single carrier, OFDMA, EXIT chart, convergence constraint