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Abstract

The mobile communication systems represent a complex research field with a large improvement potential. In the recent years, the development of Multiple Transmit and Multiple Receive (MIMO) antenna techniques has brought a new perspective in the signal processing: spatial multiplexing of data streams which facilitates large capacity improvement in the existing limited frequency spectrum. Further on, multiuser systems introduces another challenge, but also on optimization possibility: how to serve several users competing for the system resources and to take advantage of the intrinsic diversity introduced by the statistically independent channels of the users.

The aim of the thesis is the design of realistic transmit and receive signal processing in combination with resource allocation schemes for multiuser communication systems using multiple antennas and to evaluate them in different channel conditions and system setups. We use as basis the High Speed Downlink Packet Access (HSDPA) system, because it provides an appropriate model for the evaluation of the system, including adaptive modulation and coding and hybrid automatic repeat request.

The investigations start from the link level, where different MIMO processing techniques are summarized and discussed regarding their applicability to the HSDPA system. One important aspect is the design of a link to system level interface, which facilitates the time efficient system level simulations.

At the system level, the optimization of the beamforming vectors is addressed first. This optimization has to take into account that the beamforming vectors have to be designed on a long-term scale while the scheduler will select a subset of the beamforming vectors for transmission on a short term scale, depending the short term feedback from the users. Next, conditions for limiting the interference between spatially multiplexed data streams are defined and used for extending the classical scheduling strategies to the MIMO scenario. The resulting combinatorial problem is solved in a computational complexity efficient manner.

Extensive simulations are performed to determine system performance for different channel scenarios, number of active users and antenna configurations. The aim of the simulations is to estimate the gains that can be obtained by the use of multiple antennas in comparison with single antenna systems. Different measures are considered: average cell throughput, multiuser diversity gain, resource fairness and quality of service. Important conclusions are drawn that show among others that the results from link level only investigations can not be directly translated to system level, but conclusions close to the reality can be drawn only from system level investigations.