Adaptive Antenna Systems for Mobile Broadband Communications

Publication No. _____

Liang Dong, Ph.D.
The University of Texas at Austin, 2002

Supervisors: Hao Ling and Guanghan Xu

Mobile broadband communication is experiencing rapid growth in technology, markets and range of services. This rapid growth has driven the recent surge of research and development activities for high-data-rate/high-mobility wireless systems, with improved network performance and enhanced economics. One technology thrust in wireless communications is the use of adaptive antennas at the transceivers, along with the associated advanced array signal processing, to improve cell coverage, link quality and system capacity.

This dissertation first provides a framework of adaptive antenna systems for wireless communications, and characterizes the multipath fading channels of mobile broadband systems. In particular, we consider antenna systems for the base station, as well as multiple-input multiple-output systems where antenna systems are utilized at both the base station and the mobile unit. It is proved that the channel fading can be modeled and predicted using linear models of low order. The correlation of fading at multiple antennas or over the wideband is exploited to perfect channel

modeling and prediction.

Secondly, this dissertation develops the theory of adaptive antenna arrays with applications to mobile broadband systems. Through analysis of the propagation pattern and the channel structure, new techniques of uplink power control and downlink beamforming are derived to adapt to the rapid variation of the vector channel. The low variability of the channel subspace and the negligible distance between uplink and downlink channel subspaces are exploited to enhance the performance of adaptive transmission. Constraints are put on the model structure, which leads to a reduction of computational complexity of the channel estimation.

Finally, this dissertation describes the correlation of sub-channels embedded in the multiple-input multiple-output antenna systems, and discusses its effect on the channel capacity. Multiple antennas with dissimilar radiation patterns are employed to introduce decorrelation of the sub-channels, thus increasing channel capacity. Specifically, a prototype of compact antenna array at the mobile unit is proposed that exploits antenna pattern diversity.

In summary, this dissertation investigates the modeling and prediction of the time-varying multipath channels of antenna systems, while developing new techniques for mobile broadband communications that are based on the channel characterization. The general feasibility of the algorithms developed in this dissertation is demonstrated through a ray tracing simulator in various scattering environments.