PROPAGATION ASPECTS FOR SMART ANTENNAS IN WIRELESS SYSTEMS

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In this talk, we discuss the propagation issues for smart antennas in wireless systems. We first describe standard cellular antennas, smart antennas using fixed beams, and adaptive arrays for base stations, as well as terminal antennas. We then show the potential improvement that these antennas can provide, including range extension, multipath diversity, interference suppression, and capacity increase. The use of these antennas in second generation wireless systems, and their potential use in third and fourth generation wireless systems will be described. This includes discussing how M antennas at both the base station and terminal can provide an M-fold increase in capacity, providing multi-Mbps data rates to mobile users.

However, the performance of these smart antennas depends crucially on the propagation environment. This includes such propagation characteristics as angular spread, delay spread, and depolarization. Furthermore, the propagation environment can determine which type of smart antenna should be deployed. In current systems, with two receive antennas which are widely spaced, the critical issue for performance is the fading correlation, which is dependent on the angular spread. This angular spread depends on the environment (urban, suburban, or rural) and the height of the base station antenna. For these systems, multipath fading reduces signal performance, but performance improves with larger angular spread. With smart antennas techniques using two receive antennas in these systems, multipath also changes the requirements for suppression of interference.
However, smart antennas using fixed beams have degraded performance with increased angular spread. Also the performance depends on whether CDMA or TDMA techniques are used. To overcome multipath fading, dual-polarization multibeam antennas can be used, but their performance depends on the the depolarization of the received signal, which depends on the environment, height of the base station antennas, and the orientation of the terminal antenna. With adaptive antenna arrays, though, performance is *improved* with larger angular spread.

Although multipath degrades performance in current wireless systems, it actually improves performance in systems with multiple transmit and receive antennas. In this case, with M antennas at both the terminal and base station, an M-fold increase in capacity (data rate) can be achieved, but only if the multipath environment is rich enough. Without sufficient multipath, e.g., with a line-of-sight, the performance is much poorer, which is the opposite of what happens in current systems.

In this talk we will describe these issues, and present measured data to show what types of smart antennas are effective in which environments. Most importantly, we will show how smart antenna techniques have evolved to exploit the propagation environment, and describe the types of propagation measurements that are still needed to fully achieve the potential of smart antennas.

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