A Method for Characterizing Distributed Antenna System Channels using a Single-Channel Receiver

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In recent years, distributed antenna systems have emerged as a promising technique for increasing the capacity of wireless communication systems in indoor and microcell environments. Of particular interest are systems with widely dispersed antennas connected to a central communications unit by fibre optic links. Such systems may be used in several different operating modes ranging from a collection of small cells to a distributed MIMO (D-MIMO) antenna system. Models used to characterize propagation impairments on such links are much more complex than those used to characterize so-called conventional (or co-located or classical) MIMO (C-MIMO) systems because they must also account for path loss and shadow fading. Previous efforts to collect measurement data have been hampered by the need to employ relatively complex and expensive multi-channel receivers that may not always be optimal for the purpose or available to researchers.

Here we propose a technique for characterizing distributed antenna system channels using a single-channel receiver without the costs and performance limitations associated with a switch-based approach. The scheme is particularly applicable to systems that employ pseudo random binary sequences as probing signals and stepping or sliding correlator receivers to extract path loss and power delay profile data. In most systems of this sort, the capture memory is generally very deep and the total delay that can be measured far exceeds the typical delay spread observed. When systems employ widely dispersed antennas connected to a central communications unit by fibre optic links, it is a simple and inexpensive matter to increase the delay on individual links by introducing additional fibre.

A simple geometric construction based on the range of travel of the transmitter from the centroid of the distributed antennas, the distance from the centroid of the distributed antennas to the farthest antenna, and the maximum delay spread to be observed reveals the excess delay that must be introduced into each antenna path in order to effectively separate the power delay profiles observed on each link. We have summarized the results of the geometric construction in the form of design curves that demonstrate the practicality of such a scheme for use in indoor and microcell environments. We have implemented such a system using a conventional vector signal generator and single-channel digital signal analyzer. The results we have obtained further demonstrate the practicality of the approach.