Enhancing Indoor Channel Reuse Capacity through Building Propagation Modification

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Indoor wireless communication systems are often required to serve high densities of users demanding high data throughput rates. Wireless systems engineers are challenged to meet these capacity demands using the limited radio spectrum allocated for such purposes. Simultaneously reuse of radio channels in different parts of a building helps to satisfy demand. However, channel reuse risks creating intolerable levels of cochannel interference that degrades system capacity and user throughput.

Indoor environments that are characterized by high rates of attenuation over distance (e.g. because of high wall attenuation) potentially allow considerable frequency reuse because interfering signal propagation is inhibited. Unfortunately such environments also limit desired signal propagation, which may result in poor coverage or require impractically dense base station (access point) deployments.

Architectural modifications such as reflective (metal) shields and frequency selective surfaces can alter the propagation of radio signals within buildings. (J.T.P. Yiin, M. J. Neve and K.W. Sowerby, “Propagation Modeling for Indoor Wireless Systems Using the Electric Field Integral Equation”, IEEE Antennas and Propagation International Symposium /USNC/URSI National Radio Science Meeting, Toronto, Canada, July 11-17, 2010.) An initial frequency reuse study considered a single channel TDMA (time division multiple access) communication system to illustrate the effect of the in-building propagation environment (and its modification) on the timeslot reuse potential. (K.W. Sowerby and M. J. Neve “Indoor Wireless Communications Performance Improvement via Interference Control”, IEEE Antennas and Propagation International Symposium /USNC/URSI National Radio Science Meeting, Chicago, USA, July 8-14, 2012.) This work has now been extended to consider higher orders of frequency reuse and includes a metric that represents the timeslot reuse potential of any arbitrary base station deployment within a building.

Of particular interest is the wall attenuation required to achieve intense frequency reuse while maintaining coverage. The sensitivity of the reuse potential to wall attenuation is demonstrated. Understanding this sensitivity is important if wall attenuation targets are to be specified and then realized through architectural modification.

The importance of base station selection and joint power control to achieve high levels of frequency reuse are also demonstrated. Each mobile user must be paired with a base station to provide mobile service. Selections based on potential signal-to-interference ratios (SIRs) at multiple base stations are shown to result in higher levels of frequency reuse potential than conventional mobile-base parings that are determined by channel losses. Similarly, balancing SIR levels at multiple base stations through the joint power control of the multiple mobile transmitters results in much higher uplink timeslot reuse potential than can be achieved without power control.