# A Propagation Model for Close-In Distances and Very Low Antenna Heights Based on Both Electromagnetic Theory and Measured Data

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This abstract describes a radio-wave propagation model that was developed at the Institute for Telecommunication Sciences (ITS) as the result of an investigation to create a short-range mobile-to-mobile propagation model. ITS reviewed and evaluated currently available radio-wave propagation models and came to the conclusion that none of these models were suitable for addressing the requirements of ultra-short distances (2 meters to 2 km) and very low antenna heights (1 to 3 meters). The model is valid for frequencies from 150 to 6000 MHz. The combined model that has been developed is based on both analytical calculations from the physics of electromagnetic field theory and actual measurements performed in three vastly different environments: rural, urban low-rise/suburban and dense urban high-rise. The results of the analytical work are available in an ITS report.[1] The analytical method involves the calculation of the undisturbed electric field and calculation of the loss based on the amplitude of the electric field as a function of distance, frequency, and the ground constants. The undisturbed field is that electric field produced by a transmitter antenna at different distances and heights above ground without any field-disturbing factors in the proximity of the receiver antenna location. The ITS report shows via numerous examples that for most scenarios the difference between the propagation loss computed by undisturbed electric field method and a more exact theoretical methods is minimal.[1] The undisturbed electric field method includes near-field effects, the complex two-ray model, antenna heights, ground constants, antenna near-field and far-field response and the surface wave. The Undisturbed-Field Model can be used for distances out to 2 km. It is particularly applicable for close-in distances less than 30 meters. The combined model is valid out to distances of 2 km. The measurements are pseudo-mobile, since the transmitter location is fixed and the receiver is moved through the environment following a predetermined driving pattern. Environmental clutter in the real environment can give rise to non-line-of-sight conditions in which scattering and diffraction dominate, even for very short path differences. There are two facets of the environmental clutter that contribute to the radio-wave propagation problem. First are the features of the static background, such as buildings, fences, trees and other vegetation, utility poles and wires, signage, etc. Second are the dynamic background features, such as vehicular and pedestrian traffic. This presentation will describe both the analytical model and how the measured data were used to create the combined model to represent a real radio-wave propagation environment. Some of the propagation prediction results for the three different environments will also be presented.

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[1] N. DeMinco, "Propagation Loss Prediction Considerations for Close-in Distances and Low-Antenna Height Applications," NTIA Report TR-07-449, July 2007.