A Statistical Short-Range, Low-Antenna Height Propagation Model Based on Electromagnetic Theory and Actual Measurements

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This paper describes an ITS developed radio-wave propagation loss prediction model for very low antenna heights (1 to 3 meters) and very short distances (2m to 2 km) over the frequency range of 150 to 6000 MHz. The model is unique in its ability to work seamlessly over these difficult combinations of parameter ranges. The model can be applied for use in system performance prediction as well as prediction of interference phenomenon. It is based on both analytical calculations from the physics of electromagnetic theory and actual measurements performed in three vastly different environments: rural, urban low-rise/suburban, dense urban high-rise city. The topic of radio propagation between terminals in close proximity to the ground has received renewed attention recently. In cases where the terminals are close to the ground, the ground interactions of the radiated fields depart in significant ways from plane wave approximations, giving rise to the Sommerfeld representation for the total (incident plus ground interacted) field. Another important aspect for radio propagation is both immersion of the propagation path in the surrounding environmental clutter. The presence of this clutter can give rise to non-line-of-sight propagation conditions in which scattering and diffraction dominate, even for very short path distances. For a given source/transmitter location, there are two facets of the environmental "clutter" which, broadly speaking, contribute to the radio propagation problem. These are the features of the static background, such as buildings, fences, trees and other vegetation, utility poles and wires, signage, etc., and the dynamic background features, such as vehicular and pedestrian traffic. Our measurements are pseudo-mobile. That is, our transmitter location is fixed at a specific location and we then move our receiver through the environment, sampling the field over approximately 1 second intervals in time sequentially, by following a predetermined driving pattern along the street grid in the environment. One can surmise that there are two sorts of variability that cannot really be separated by measuring the field in this manner. There is the inherent position dependence of the field based on the static background along with the short term average or median dynamic background. This static component of the variability is almost completely deterministic, if one can capture sufficient detail about the structure of the static background and suitable time averages or medians of the dynamic background. Our measurements incorporate a sort of average or median value of the dynamic background, albeit one that is location/position dependent.