Investigating the Standard Deviation of the Distribution of Scatterers in Cellular Environments

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Physical and statistical properties of the scatterers existing between transmitter and receiver have to be studied in order to design reliable channel models. Wireless signal propagation changes in different environments according to scatterers' density. It is reasonable to assume that the majority of scatterers are located closer to mobile station (MS) and the density of scattering points decreases as the distance from MS increases [1, 2]. Gaussian, Laplacian, exponential, and hyperbolic distributed scatterers are examples of scattering models employing this principle of tapering-off of scatterers. For instance, Gaussian Scatter Density Model (GSDM) [1, 3] assumes Gaussian (normal) distribution for the scattering points around MS. Thus, the value of standard deviation of the distribution of scatterers, σ, plays an important role in determining the width of the scattering region and, hence, in applying the model to a specific environment.

If the density of scattering points decays sharply as the distance from MS increases, then the probability density function (pdf) of Angle of Arrival (AoA) of the multipath signal at BS will have rapidly decaying tails. Thus, the model accounts only for scatterers in the close vicinity to MS, which will have the major effect on the received signal at BS. On the other hand, if the density of scattering points decays slowly as the distance from MS increases, then the pdf of AoA of the multipath signal at BS will have heavy tails. In this case, the model accounts also for farther scatterers from MS, which have considerable effect on the received signal at BS.

A general rule of thumb was proposed in [1] for the first order approximation of the standard deviation based on experimental data. It was assumed that the stronger multipath echoes that arrive at BS shortly after Line of Sight (LoS) signal are due to scattering points close to MS while multipath echoes with larger delay values are due to scattering points farther from MS. The study in [3] found that the pdf of AoA depends on a single parameter which represents the ratio of the distance between BS and MS, D, and the standard deviation of the distribution of Gaussian distributed scatterers around MS, σ. Recently, a model for NLoS propagation in street-guided environment has been reported in [2], where it was found that $\sigma = 1/6\times$ street width is the best value for the standard deviation to fit field measurements of Power Azimuthal Spectrum (PAS). In [4], the value of standard deviation was related to cross correlation of the fading between antenna elements spaced by distance d, $\rho(d)$, and the wavelength of the carrier frequency, λ, as, $\sigma = \sqrt{\frac{\lambda^2 ln(\rho(d))}{-4\pi d^2}}$. Here, several techniques are studied for predicting accurate values for the standard deviation of the distribution of scatterers. We examine several measurement campaigns for different cellular environments in order to deduce information about the actual distribution of scatterers in these environments.

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