Frequency Correlation Function for 2D-Trunk Dominated Forest

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With the emergence of 5G wireless communications systems, there is the need to assess and improve the capacity of these systems. The improvements should not come just by meeting the required loss between the transmitter and the receiver, but should also come from the modulation and multiple access schemes that spread the transmission over wide bandwidths. To realize the increased capacity of these new systems, it is important to understand the coherent bandwidth of the propagation channel. The objective of this presentation is to describe a stochastic radiowave propagation model useful for assessing the effects of a 2D-trunk dominated forest on the correlation bandwidth of a 5G communication system.

Consider an idealized problem of an electric line source in an unbounded medium of thin parallel randomly placed trunks. This model will be used to show how the correlation bandwidth changes as a function of propagation distance. With the line source parallel to the trunks, the problem can be reduced to two dimensions. Using the ladder approximation to the Bethe Salpeter equation, one can derive an equation for the two frequency correlation function which depends on the observer's location. In the case of trunks whose radius is small, compared to a wavelength, the equation reduces to a convolution and can be solved exactly.

The channel consists of a sum of a coherent and an incoherent component. Our attention will focus on the incoherent component which is dominant at long distances from the source. In this limit an approximate expression for the two frequency correlation function is derived. If the two frequencies are represented in terms of sum and difference frequencies, plots of the correlation function versus the frequency difference can be obtained. Several of these two frequency correlations functions will be presented for various UHF frequencies. Finally, the correlation bandwidth is shown as a function of path length from the source. The function shows that the correlation bandwidth decreases as the path length increases. This demonstrates that for a particular frequency and correlation bandwidth, there is a limited path length in which the incoherent channel can be used for communication.