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Statistical modeling and characterization of wireless channels with multi-clustered scattering

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Key skills: *Electromagnetic waves, statistics, special mathematical functions.*

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Background

Wireless communications require propagation of electromagnetic waves from the transmitting antenna to the receiving antenna conveying the useful information from the source to the destination. The nature of the wireless environment makes the transmitted electromagnetic wave to arrive at the receiver into a form of several replicas of the initially transmitted wave. The terminology "multipath components" is used for these replicas, which are attenuated and time-delayed versions of the transmitted wave. During the transmission, the electromagnetic waves undergo three types of variations, namely, a) small scale variations, b) large scale variations and c) path loss [1, Ch. (5)]. Small scale variations or small scale fading are caused by interaction of multipath components with each other resulting fluctuations of the received signal occurring within a local area, i.e., variations in space comparable with the size of the wavelength of the carrier [2, Ch. (4)]. According to the nature of the wireless environment, the transmitted signal bandwidth, and the overall distance that electromagnetic waves travel from the transmitting antenna to the receiving antenna, propagation can be confined within resolved clusters [1, Ch. (7)]. The number of resolved clusters increases when the transmitted signal bandwidth increases or/and the scatterers are more densely distributed (e.g., in an urban environment compared to a suburban). Superimposed on the small variations are the large scale variations or large scale fading, which is the result of variations in the average received local power for a given transmitter-receiver distance. Large scale variations arise from variations in space of the order of hundreds of wavelengths and are attributed to shadowing or shadow fading caused by large objects occupying the path from the transmitter to the receiver. Both small scale and large scale variations exhibit random behaviour, thus statistical tools and analyses are required for their characterization. Path loss is a deterministic variation arising from variations of the average received power with respect to the distance between the transmitting and receiving antennas. The proposed research will focus on statistically modeling of small scale and large scale variations in wireless channels, both separately and jointly. Focus will be given on multi-clustered channel modeling, which is more evident when the frequency of operation increases, making the proposed research particular useful for extremely high frequency bands (e.g., 60GHz band).

Programme

The aim of this PhD is to create novel statistical models complying with the underlying physics of propagation and being as close as possible to realistic scenarios. The programme is a rich blend of theory, computer simulation and experimentation and has the following milestones:

i. Deep literature review and evaluation (8 months)
ii. Analysis of possible solutions and transfer report (12 months)
iii. Results from statistical modeling of small scale and large scale variations with multi-clustered scattering and 2nd year report (24 months)
iv. Results from joint statistical modeling of small scale and large scale variations (30 months)
v. Thesis submission (36 months)

Impact potential

The researcher is encouraged to publish in leading academic journals. Examples relevant to this programme of study are: IEEE Transactions on Wireless Communications, IEEE Transactions on Vehicular Technology, IEEE Transactions on Communications, IET Communications. The researcher is encouraged to develop exploitable outputs. Examples pertinent to this programme of study are: attracting funds and contributing to standardization bodies.

References

[1] A. F. Molisch, “Wireless Communications,” Wiley, 2005.
[2] G. D. Durgin, “Space-Time Wireless Channels,” Prentice Hall, 2003.