Copernicus Visiting Scientist Seminar
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Generalized Models for Fading
With Diffuse Scatter Plus Line-of-Sight Components

New applications, as well as user demands for improved quality of services, create a need for improved channel models and better understanding of existing channel models. In particular, high mobility wireless channels are sometimes not well characterized by the popular wireless channel models. This motivates revisiting some wireless channel models that may not have found widespread usage in the past, as well as developing new flexible models that extend popular methods in physical as well as intuitive ways. For example, while the Rayleigh fading model describes a diffuse multipath signal and the Rician fading model describes a diffuse propagation environment with a single line-of-sight (LOS) component, there may be applications where there are two or more specular waves (components), giving rise to the two-wave diffuse power model (TWDP) of Durgin, Rappaport and de Wolf. While it can represent many practical wireless communication channels and has obvious added flexibility, the mathematics of this model are complex, and in particular, computation of this model's infinite series solution is problematic for certain choices of channel parameters. This leads to the use of approximations for the relevant statistics and distributions.

In this talk, we find exact infinite series solutions for the statistics and distributions of the TWDP wireless channel as well as efficient and precise recursive algorithms for their computation. The overall solution is efficient and precise for all practical values of channel parameters. A second real wireless channel scenario we consider is the case where LOS propagation is present but more flexibility is required in modeling the diffuse propagation environment than the Rician distribution affords. Some researchers have used the Nakagami-m distribution for this case. However, we argue that the Nakagami-m distribution can neither physically nor mathematically represent a fading scenario with a LOS component. That is, the Nakagami-m fading model can exclusively represent sums of diffuse waves in multipath propagation. We introduce a novel fading model that combines a LOS component with a diffuse fading component modeled by the Nakagami-m distribution. Solutions for the PDF of the proposed fading model are found in terms of infinite series and as a finite sum in terms of the hypergeometric functions. The behaviors of the new diffuse Nakagami-m with LOS distribution fading model are investigated and compared to the behaviors of the Rice, Nakagami-m and two-wave diffuse power(TWDP) fading models. We modify some existing LOS fading models and propose a second novel fading model. We consider a LOS propagation environment with a diffuse component, this time modifying the generalized Rician distribution. This novel fading model unifies the non-central chi, generalized Ricean and kappa-mu fading models. The new fading distribution is given in closed-form and the effects of the parameters of the probability density function on its shape and location are demonstrated. Expressions are derived for the cumulative distribution function, moments and K-factor. Comparison among these fading models shows the new fading distributions to be flexible models for a wireless channel with both LOS components and diffuse scatter components, allowing for adjustment of the severity of the fading channel modeled.

Speaker Biography

Dr. Norman Beaulieu received the BASc. (honours), MASc, and PhD degrees in electrical engineering from the University of British Columbia, Canada in 1980, 1983, and 1986, respectively. He was awarded the University of British Columbia Special University Prize in Applied Science in 1980 as the highest standing graduate in the Faculty of Applied Science. Dr Beaulieu was a Queen's National Scholar Assistant Professor with the Department of Electrical Engineering, Queen's University, Canada from 1986 to 1988, an Associate Professor from 1988 to 1993, and a Professor from July 1993 to 2000. In 2000, he became the iCORE Research Chair in Broadband Wireless Communications at the University of Alberta, Edmonton, Alberta, Canada, in 2001, the Canada Research Chair in Broadband Wireless Communications, and in 2010 the AITF Research Chair in Broadband Wireless Communications. Dr Beaulieu received the Natural Science and Engineering Research Council of Canada (NSERC) E.W.R. Steacie Memorial Fellowship in 1999. He was elected a Fellow of the Engineering Institute of Canada in 2001, a Fellow of the Royal Society of Canada in 2002 and a Fellow of the Canadian Academy of Engineering in 2006. In 2004, he was awarded the Medaille K.Y. Lo Medal of the Engineering Institute of Canada. He was awarded the Thomas W. Eadie Medal of the Royal Society of Canada in 2005, as well as the Alberta Science and Technology Leadership Foundation ASTech Outstanding Leadership in Alberta Technology Award. He was the 2006 recipient of the J. Gordin Kaplan Award for Excellence in Research, the University of Alberta's most prestigious research prize. Dr Beaulieu is listed on ISIHighlyCited.com and was an IEEE Communications Society Distinguished Lecturer in 2007/2008 and 2014/2015. He is the recipient of the IEEE Communications Society 2007 Edwin Howard Armstrong Achievement Award. Dr. Beaulieu is the recipient of both the 2010 R.A. Fessenden Silver Medal and the 2010 Canadian Award in Telecommunications. In 2011, he was awarded the IEEE Communications Society Radio Communications Committee Technical recognition Award, and in 2013, the Signal Processing and Communications Electronics Technical Committee (Inaugural) Technical Recognition Award. In 2014, he was awarded the Copernicus Visiting Scientist by the University of Ferrara.