BCWS Seminar Series

INFORMATION THEORY AND ELECTROMAGNETISM: ARE THEY RELATED?

by

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Time: Wednesday, April 28, 1:30 - 2:30 pm
Place: Room 4356, Mackenzie Building, Carleton University

Abstract: We study the limitations imposed by the laws of electromagnetism on achievable MIMO channel capacity in its general form. Our approach is a three-fold one. First, we use the channel correlation argument to demonstrate that the minimum antenna spacing under any scattering conditions is at least half a wavelength. Secondly, using a plane-wave spectrum expansion of a generic electromagnetic wave combined with Nyquist sampling theorem in the spatial domain, we show that the laws of electromagnetism limit the minimum antenna spacing to half a wavelength (in the case of 1-D antenna apertures) only asymptotically, when the number of antennas increases to infinity. For a finite number of antennas, this limit is slightly less. The number of antennas and, consequently, the MIMO capacity is limited for a given aperture size. This is a scenario-independent limit. Finally, we study the MIMO capacity of waveguide and cavity channels. The rationale for this is three-fold: (i) waveguide / cavity models can be used to model corridors, tunnels and other confined space channels, (ii) this is a canonical problem; its analysis allows to develop appropriate techniques, which can be further used for more complex problems, (iii) it allows to shed light on the relation between information theory and electromagnetism and, in particular, to establish the limits imposed by the laws of electromagnetism on achievable channel capacity and in compact, clear form.

Biography: Sergey Loyka (M'96-SM'04) was born in Minsk, Belarus. He received the Ph.D. degree in Radio Engineering from the Belorussian State University of Informatics and Radioelectronics, Minsk, Belarus in 1995 and the M.S. degree with honors from Minsk Radioengineering Institute, Minsk, Belarus in 1992. Since 2001 he has been a faculty member at the School of Information Technology and Engineering, University of Ottawa, Canada. Prior to that, he was a research fellow in the Laboratory of Communications and Integrated Microelectronics (LACIME) of Ecole de Technologie Superieure, Montreal, Canada; a senior scientist at the Electromagnetic Compatibility Laboratory, Belorussian State University of Informatics and Radioelectronics, Minsk, Belarus; an invited scientist at the Laboratory of Electromagnetism and Acoustic, Swiss Federal Institute of Technology Lausanne (EPFL), Switzerland. His research areas include wireless communications and networks, MIMO systems and smart antennas, RF system modeling and simulation, and electromagnetic compatibility, in which he has published extensively.