Seminar at Foton Laboratory

The Limits of Optical Fibers to Transmit Information

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Abstract:
The maximum rate of transmission of information over single-mode optical fibers has increased by four orders of magnitude over the last three decades. A question naturally arises: is there a fundamental limit to the maximum achievable transmission rate, or capacity, of single-mode fibers?

In the first part of this presentation, I will discuss studies on the capacity limit imposed on single-mode fibers by the Kerr fiber nonlinearity and Shannon`s information theory. I will show that the record capacities achieved experimentally are currently within a factor 2 from the maximum capacity predictions and appear to be saturating near this level. I will discuss the technologies needed to closely approach the nonlinear fiber capacity limit and the variation in the capacity of various single-mode fiber types.

Assuming that we cannot exceed the predicted capacity limit of single-mode fibers, what are the alternatives to increase fiber capacity? Can multimode, few-mode and multicore fibers be an alternative to multiple single-mode fibers? In the second part of the presentation, I will discuss how space-division multiplexing (SDM) over a single fiber strand can be used for increasing capacity using technologies such as multiple-input multiple-output (MIMO) digital signal processing (DSP) and spatial mode couplers. I will also present evidence of nonlinear limitations in transmission over SDM fibers with the experimental observation of inter-modal nonlinear effects in a 5-km long few-mode fiber.

René-Jean Essiambre received the Ph.D. degree in Physics (Optics) from Université Laval in Québec City in 1994. From 1995 to 1997, he was at the Institute of Optics of the University of Rochester, Rochester, NY. Since 1997, he has been at Bell Laboratories, Alcatel-Lucent, Holmdel, New Jersey, USA.

His early research areas are optical switching, soliton communication systems, high-power fiber lasers, and mode-locked fiber lasers. His current research interests include high-speed transmission (400 Gb/s and above), the physical layer design of fiber-optic communication systems, the application of information theory to fiber-optic communication systems and space-division multiplexing in multimode and multicore fibers. He is the author and coauthor of more than 150 scientific publications and several book chapters. He has served on or chaired many conference subcommittees including ECOC, OFC, CLEO, and LEOS and is the Program Co-Chair of CLEO: Science & Innovations 2012 and General Chair for 2014. Dr. Essiambre is a Fellow of both the Optical Society of America (OSA) and the Institute of Electrical and Electronics Engineers (IEEE), the recipient of the 2005 OSA Engineering Excellence Award and a Distinguished Member of Technical Staff at Bell Laboratories

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