All-optical 2R regeneration of multi-channel WDM signals

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All-optical regeneration is one of the key enablers of future transparent optical networks. However, the advance of this technology into practical communication systems has been hindered by its apparent incompatibility with WDM: all-optical regeneration relies on large amount of intra-channel optical nonlinearity, which is always accompanied by debilitating four-wave-mixing (FWM) and cross-phase-modulation (XPM) interactions among the channels, which prohibit WDM operation.

The talk will present the recent work of Prof. M. Vasilyev's group on solving this fundamental problem by developing 2R regenerators scalable to large WDM channel counts (done in collaboration with Prof. T. I. Lakoba from the University of Vermont).

The key element in our approach is a novel nonlinear medium with a special dispersion map that is both spatially- and spectrally-periodic (we call it a group-delay-managed, or GDM, medium to distinguish it from conventional dispersion-managed links). In the lab, we build it from short pieces of highly-dispersive highly nonlinear fiber, separated by phase filters with periodic saw-tooth-like group-delay spectra, so that the group-delay spectrum of each fiber-filter unit section looks like a staircase. Hence, in GDM medium, different WDM channels propagate with very different group velocities (which suppresses FWM and XPM), whereas various frequency components of the same channel travel with the same velocity, preserving the pulse integrity and ensuring accumulation of self-phase-modulation (SPM).

The talk will discuss our experimental results demonstrating the GDM-enabled simultaneous regeneration of up to 12 WDM channels (at 10 Gb/s each) in Mamyshev 2R regenerator based on SPM spectral broadening followed by offset bandpass filtering. With 200-GHz channel spacing required to accommodate spectral broadening in the Mamyshev scheme, we have observed no inter-channel penalties.

A discussion of the potential ways in which the novel GDM medium can benefit other 2R regenerator types, different spectral efficiencies, bit rates and modulation formats will conclude the presentation.

Speaker's bio

Michael Vasilyev received the M.S. degree in Physics from Moscow Institute of Physics and Technology, Russia, in 1993, and the Ph.D. degree in Electrical Engineering from Northwestern University, Evanston, IL, in 1999. During his doctoral work he has demonstrated the first noiseless image amplifier and first noiseless fiber amplifier, based on phase-sensitive parametric amplification. He has also developed and experimentally realized multimode quantum-state tomography to measure joint photon statistics of parametric twin beams.

In 1999 Dr. Vasilyev joined Corning Inc. (Somerset, NJ) as a senior research scientist, where he performed experimental and theoretical studies of noise and nonlinearities in optical fibers and amplifiers. Among his credits are the invention of symmetric dispersion-managed fiber and demonstration of optical OADM / OXC networking with 6400 Tb/s x km capacity-reach product.

In 2003, he joined the Department of Electrical Engineering at the University of Texas at Arlington as an Assistant Professor, and became Associate Professor in 2009. There he is working on lumped and distributed multimode phase-sensitive amplifiers, multi-channel all-optical regenerators and signal processors, and nanoscale nonlinear and quantum optics. Dr. Vasilyev has published 35 journal and over 80 conference papers, and holds 8 patents.