Guest Editorial

Special Issue on Polarization Effects in Fiber-Optic Networks

POLARIZATION mode dispersion (PMD) is an important impairment in high-speed long-distance fiber-optic communication systems. PMD is associated with the deformation of the propagating optical pulses due to the slight random birefringence in the optical fiber and other in-line components, introduced through manufacturing, cabling, and installation of the optical link. The random nature of the PMD sets it apart from other impairments in the optical fiber and makes it a fascinating research subject but, at the same time, potentially one of the most challenging limiting factors for future optoelectronic transmission. Not only do the magnitude and direction of the PMD vector change randomly from one wavelength channel to another, they also change in time for a given channel over timescales ranging from hours to microseconds. Matters are further complicated by the interaction of PMD with the polarization-dependent loss (PDL) and optical nonlinearities in the link.

The temporary overbuild of the fiber plant during the telecom bubble, using low-PMD fibers, has allowed a wide-spread deployment of 10G systems, obliterating the need for immediate PMD compensation. For a while, most carriers seemed to have enough recent-vintage fiber to satisfy the increasing demand of their customers, using multiple wavelength-division-multiplexed (WDM) channels to form Terabit per second links. However, as the telecommunication industry comes out from a long downturn, there is a renewed interest in PMD, as it needs to be taken into account for the worldwide deployment of 40G systems, which has already started to take place.

The continuous growth of Internet traffic, the emerging IPTV market with its insatiable demand for superb quality of service, and the booming FTTx market, together with reasonably priced commercial 40G systems, pushes most carriers to upgrade their long-haul systems to 40G, if not beyond. At these high bit rates, it is not only the PMD and PDL of the fiber that have an impact on system performance; components also play a significant role in the overall PMD/PDL budget. Many in-line components populate current systems (e.g., optical amplifiers and dispersion compensation modules), and even more sophisticated ones, such as wavelength blockers, wavelength selective switches, reconfigurable add-drop multiplexers, and optical routers, are expected to be important ingredients of future mostly optical networks. Being discretely distributed along the link in multiple locations, these components affect PMD-induced outages through their own nonnegligible (though deterministic) PMD and some of them, behaving as polarization rotators, also affect the statistics of PMD-induced penalties.

In the last 20 years, a large body of work has been created to better understand the origins of the PMD and its behavior in installed fibers to create better fibers for high-bit-rate transmission and to develop practical means for PMD characterization and mitigation. Yet, the resurgent threat posed by polarization effects in fiber-optic networks to the development of next-generation systems justifies another JLT Special Issue devoted to this subject. Recent research covered in the following invited and contributed articles can be roughly divided into seven overlapping subfields, each involving both theoretical and experimental work: 1) study of fiber’s PMD: its characteristics, statistics and dynamics in installed plant, interplay of PMD, PDL and nonlinearities, nonlinear polarization crosstalk, and polarization properties of novel telecommunication and specialty fibers (especially microstructured fibers); 2) faithful emulation of the PMD for single and multicore channel testing; 3) in-service monitoring of PMD/PDL and their induced penalties; 4) novel modulation formats tailored for systems with uncompensated and/or compensated PMD; 5) system aspects of the PMD: calculation and measurement of outage statistics, which is of supreme importance for network operators, development of optimal PMD avoidance strategies, etc.; 6) PMD compensation by optical and electronic means; and finally, 7) additional polarization-related effects in fiber and components.

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We, the Guest Editors, hope that this Special Issue will not only provide good coverage of the state-of-the-art of research on the polarization effects in fiber-optic networks but will also prompt veterans and newcomers to come up with winning solutions to the challenging polarization-induced impairments in these important systems.

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