Abstract

Chromatic dispersion management is an important part of today's fiber optic networks. In the future, when high tranmission capacity is necessary, other than amplitude, the phase of optical carrier can be explored to support bandwidth requirement. Transmission systems such as Differential-Phase-Shift-Keyed (DPSK) and Differential-Quadrature-Phase-Shift-keyed (DQPSK) will become promising alternatives for future fiber optic networks. Therefore, the implementation of chromatic dispersion compensation in advanced Wavelength Divison Multiplexed (WDM) phase-shift-keyed transmission systems is addressed in this dissertation. By using advanced modulation formats, namely DPSK, DQPSK and polarization division multiplex (PolDM), numerous fiber impairments need to be considered in chromatic dispersion management. Besides the chromatic dispersion itself, intrachannel effects, nonlinear phase noise, and the resonance generated from Cross Phase Modulation (XPM) and Four Wave Mixing (FWM) are also important. The transmission experiments in 160 Gbit/s system, developed from 40 Gbaud DQPSK with PolDM, in a WDM environment were successfully conducted in a conventional Dispersion Compensating Fiber (DCF) supported network. By using a low cost DCF-based chromatic dispersion compensator for residual dispersion compensation, performance above the Forward Error Correction (FEC) limit was achieved over span lengths of up to 100 km, and transmission capacity of around 5 Tbit/s. In 40 Gbaud WDM dynamic dispersion compensation experiments, the transmission line (SSMF) dispersion was successfully compensated by using a 10 Gbit/s Chirped-Fiber Bragg grating-based multichannel tunable dispersion compensator (MTDC). Among all modulation formats used, the best performance was shown in DPSK, where compensation value of up to -1520 ps/nm was implemented. This compensation value has successfully compensated chromatic dispersion of 94.2 km SSMF. Successful test on 80 Gbits/s WDM DQPSK system pushed the potential of this 10 Gbits/s MTDC to the limit. It is concluded that at 33 GHz bandwidth, MTDC is suitable for short span networks. For long-haul systems a bandwidth of at least 60 GHz is required to avoid a bandwidth limitation penalty. We suggest that the combination of MTDC and Non-zero Dispersion Shifted Fiber (NZDSF) is the best solution to produce a high performance future fiber optic network. Combining MTDC with arrival time detection, automatic chromatic dispersion compensation was demonstrated in all 40 Gbaud formats (OOK, DPSK and DQPSK). This dissertation validates the possibility of using conventional dispersion management to support the systems that implement advanced modulation formats, and the need and feasibility of implementing advanced dispersion management to further improve the performance of these systems.