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Simulation and analysis of dispersion compensation schemes for 100 Gbps PDM–OFDM optical communication system

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ABSTRACT

In this paper, the implementation of 100 Gbps optical communication system exploiting polarization diversity at transmitter and receiver is developed and investigated with pre-, post- and symmetrical dispersion compensation schemes by using dispersion shifted and dispersion compensated fibers through simulations to optimize high data rate optical transmission. Motivation to the current analysis is to compare all 3 compensation schemes and it's found that the pre compensation technique is superior to post and symmetrical compensation techniques in 100 Gbps PDM–OFDM communication system. On examination of symmetrical and post dispersion compensation schemes, it's found that the later is superior to the previous in this case. A 100 Gbps coherent optical OFDM workplace has been discovered in which two 50 Gbps data streams are combined into one wavelength by polarization beam combiner. By comparing one can get a promising system to the symmetrical high capacity access network with high spectral efficiency, cost effective, good flexibility.

1. Introduction

Orthogonal frequency-division multiplexing (OFDM) has been studied to overcome RF microwave multipath fading and has emerged as the leading modulation technology for the wireless and wire-line systems in RF domain. Recently, an optical equivalent of RF OFDM called optical OFDM (CO-OFDM) has been proposed [1] and has become a promising technique for high spectral efficiency and dispersion resilient transmission [2,3]. OFDM is a widespread technology in broadband communication because of its ability to handle strong channel distortions (interference, frequency fading, and multipath propagation). OFDM takes advantage of FFT to achieve a high spectral efficiency and perform easy channel equalization. For these reasons, optical OFDM has been known as an attractive solution for optical long-haul transmission, because it offers a reduced signal bandwidth and enables simple digital equalization of chromatic dispersion [4].

Direct detection and coherent detection are two schemes for detection of optical OFDM at the receiver. Coherent detection is better than direct detection [3]. Shieh et al. attempted to combat PMD by using polarization receiver diversity, that basically could be a pair of SIMO–OFDM system and shown that PMD can be reduced without using an optical compensator [5]. Shieh et al. [6] recovered a CO-OFDM signal after 900 ps DGD and 1000 km transmission through SSMF fiber without dispersion compensation.

107 Gb/s QPSK-encoded CO-OFDM signal transmission over SMF beyond 1000 km without dispersion compensation and without Raman amplification was done by Shieh et al. [7]. As we know, OFDM is inherently resilient to dispersion, but after a long distance transmission dispersion gets accumulated. If we want to increase transmission beyond this we have to implement dispersion compensating schemes. Dispersion compensated fibers can be used with standard single mode fiber or dispersion shifted fiber to compensate dispersion. Hayee et al. employed pre- compensation and post-compensation in 10 Gb/s WDM system [8]. Kaler et al. investigated pre-, post- and symmetrical compensation in 10 Gbps NRZ links using standard and dispersion compensated fibers [9].

In this paper we have developed CO-OFDM optical communication system of 100 Gb/s with NRZ (non return to zero) as line coding and QAM-4 for mapping and after this OFDM modulation is implied. Here in this paper, we compare these three dispersion compensation methods and evaluate the performance characteristics of 100 Gb/s CO-OFDM system using polarization multiplexing. The results of pre-, post- and symmetrical compensation are compared on the basis of BER and Q. In Section 2, system configuration and in Section 3, results and discussion are discussed and in Section 4, conclusion is outlined.

2. System configuration

The block diagram of basic architecture of CO-OFDM system using polarization multiplexing is shown in Fig. 1.

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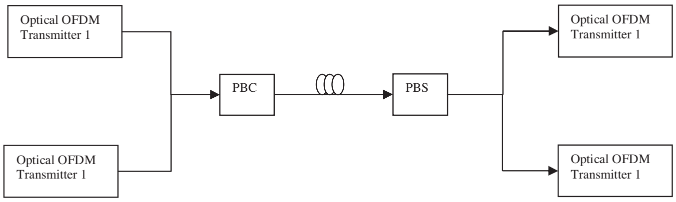

Fig. 1. CO-OFDM system using polarization multiplexing and demultiplexing at transmitter and receiver respectively. PBS/C stands for polarization beam splitter/combiner.

This system is designed using optisys version 11, which is used as platform for many optical communication design and simulation. Optical OFDM transmitter includes RF OFDM transmitter and RF to optical up convertor. Optical OFDM receiver includes OFDM receiver and optical to RF down convertor. PBC is used as polarization beam combiner at transmitting end, whereas PBS is used as polarization beam splitter at receiving end. By using PBC system capacity is doubled.

In Fig. 2 simulation set up of transmitter and receiver of 100 Gbps PMD–OFDM optical communication system is given.

Two 50 Gbps data are first mapped by QAM-4 then they are modulated by OFDM modulator. These OFDM modulated data are then optical up converted using different polarization and in last these are polarized combined and sent through fiber. At receiving end a polarization splitter splits both OFDM modulated data then these are detected by coherent detection at receiver and demodulated by using OFDM demodulator. Then QAM-4 sequence decoder is used at the receiver. Dispersion compensated fiber has attenuation of 0.2 db/km and dispersion coefficient of 3.3 ps/nm/km (Table 1). In QAM sequence encoder and decoder 'bits per symbol = 2' is taken.

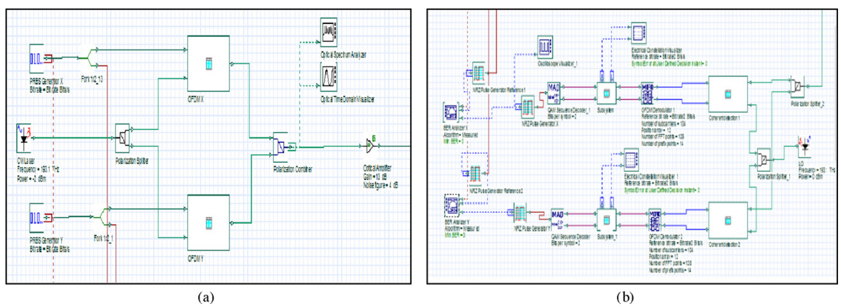

Fig. 2. Simulation set up of PMD–OFDM 100 Gbps optical communication system (a) transmitter; (b) receiver.

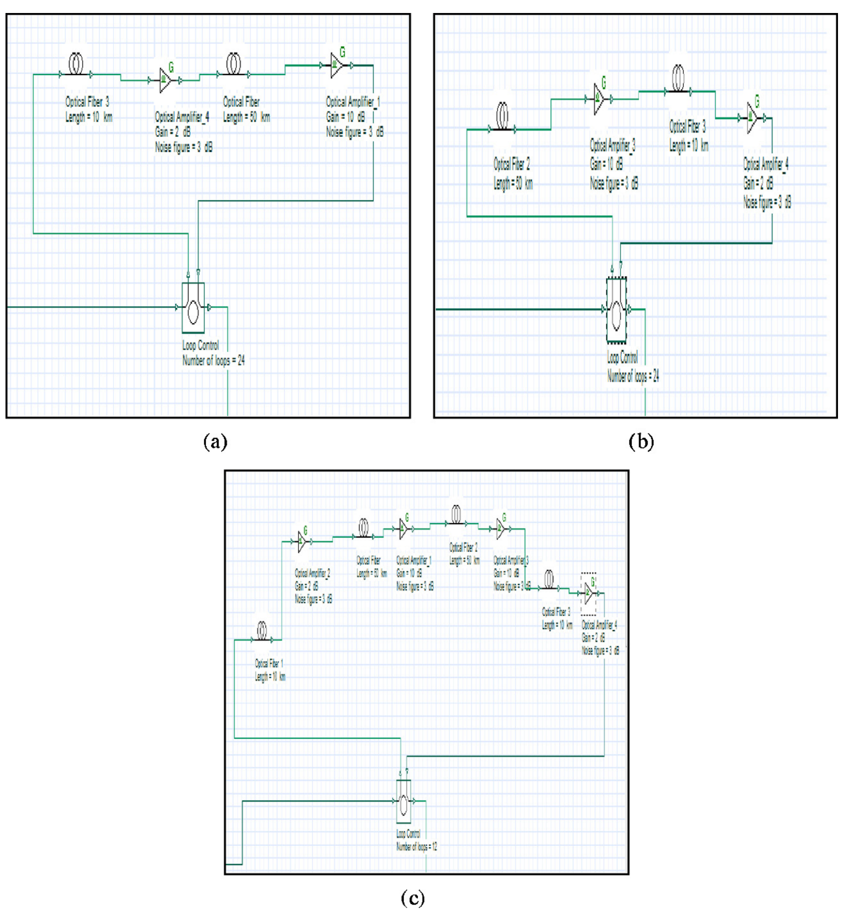

Fig. 3. Simulation set up (a) pre-compensation with 50 km link with 24 spans; (b) post-compensation with 50 km link with 24 spans; (c) symmetrical compensation with 100 km link with 12 spans using dispersion shifted and dispersion compensating fibers.