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Seoane, Jorge; Siahlo, Andrei; Clausen, Anders; Oxenløwe, Leif Katsuo; Zhenbo, Xu; Jeppesen, Palle

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All optical 160 to 10 Gbit/s demultiplexing using co-propagating optical clock

J. Seoane, A. I. Siahlo, A. T. Clausen, L. K. Oxenløwe, Z. Xu, P. Jeppesen

Research Center COM, Technical University of Denmark, Kgs. Lyngby, DK-2800, Denmark

jsg@com.dtu.dk

Abstract: All optical demultiplexing of a 160 Gbit/s optical time domain multiplexed signal using a co-propagating 10 GHz optical clock as control signal into a nonlinear optical loop mirror is demonstrated.

OCIS codes: (060.4510) Optical communications; (060.2360) Fiber optics links and subsystems

1. Introduction

As research interest is shifted to bit rates beyond 40 Gbit/s, the lack of electronics coping with these bit rates has made Optical Time Domain Multiplexing (OTDM) the technology of choice. This increases the complexity of the receiver. Common schemes require a clock recovery circuit driving a laser source [1,2] or high-speed electro absorption modulator (EAM) [3]. We demonstrate a simplified receiver configuration in which a co-propagating 10 GHz optical clock based on narrow pulses is used, without O/E-conversion, to generate the switching window in a Nonlinear Optical Loop Mirror (NOLM) based receiver.

2. Experimental setup

A schematic of the experimental setup is shown in Fig. 1. A single mode-locked fiber ring laser (ML-FRL) generates 10 GHz pulse trains at 1558 nm, corresponding to the zero dispersion wavelength of the link. A pulse train is modulated by a Mach-Zehnder modulator using 2^7-1 to 2^{31}-1 PRBS data, and injected into a 2^7-1 PRBS maintaining multiplexer (MUX) to generate a 160 Gbit/s OTDM data stream. A second pulse train is launched into a λ-converter unit based on a NOLM to generate the optical clock signal at 1540 nm.

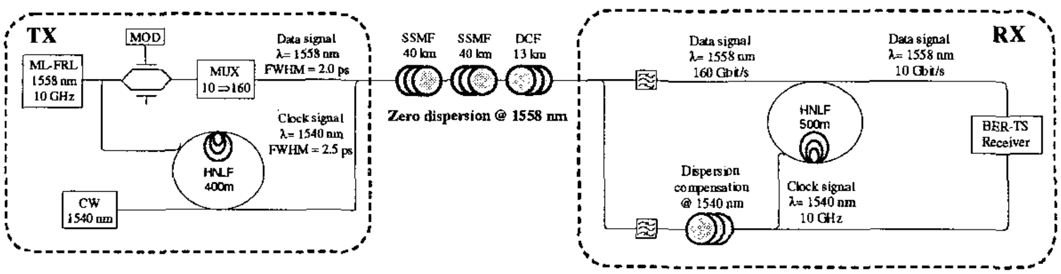

Fig. 1. Experimental setup. A single pulse source is required for generation and demultiplexing. Broadening of the clock signal is minimized at the receiver by adding extra length of SSMF

The link comprises 80 km of Standard Single Mode Fiber (SSMF) and 13 km of Dispersion Compensating Fiber (DCF). At the receiver, the data and clock signals are independently recovered by optical filtering. The clock signal is further optically split into two. First part serves as reference for bit error rate (BER) measurements after O/E-conversion. The second part is injected into the demultiplexing NOLM to generate the switching window.

3. Discussion

Fig. 2 presents the autocorrelation traces of data and clock signals injected into the demultiplexing NOLM. The figure demonstrates the feasibility of co-propagating optical clocked signals as a means to generate an appropriate switching window at the receiver. Wavelength separation between data and clock signals, shown in the inset, ensures negligible spectral overlap.

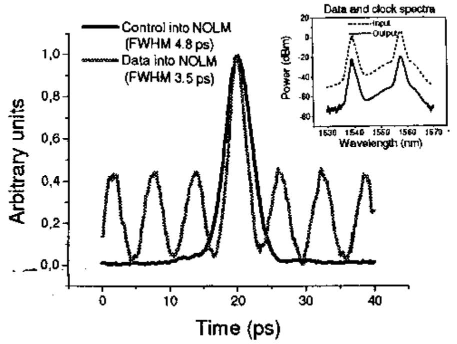

Fig. 2. Autocorrelation and spectra traces of data and clock signals.

BER measurements are presented in Fig. 3. A low 2 dB sensitivity penalty with no error floor was observed after transmission. Eye diagrams of the original 160 Gbit/s OTDM signal are presented in the upper inset. Upper and bottom eye diagrams of the lower inset show respectively a typical demultiplexed optical signal and the corresponding electrical signal injected into the receiver at BER of 1×10^{-9}.

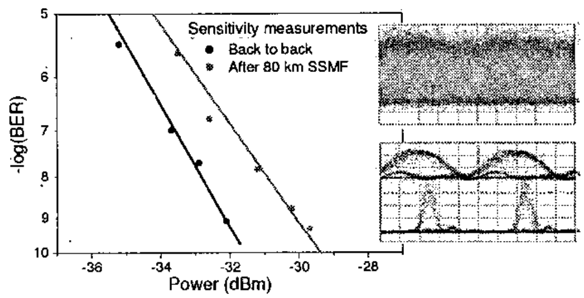

Fig. 3. BER measurements and eye diagrams of the data and a typical demultiplexed signal.

4. Conclusion

All optical demultiplexing of a 160 Gbit/s OTDM signal to the 10 Gbit/s line rate has been demonstrated with a single pulse source using a co-propagating 10 GHz optical clock to generate a sufficiently narrow switching window in a NOLM-based receiver. Low transmission penalty and no error floor were observed. The amount of equipment required for demultiplexing OTDM systems is minimized.

Reference

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