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40Gbit/s OTDM to 4x10Gbit/s WDM conversion via birefringence switching

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Abstract
We implement a scheme for 40Gbit/s OTDM to 4x10Gbit/s WDM conversion using a sequential wavelength pulse train and wavelength conversion via birefringence switching in a semiconductor optical amplifier.

1 Introduction

In future high data capacity photonic gateways [1] it may become advantageous to avoid unnecessary optical–electrical and electrical-optical conversions in order to minimize costs, reduce overall power consumption and have less space requirement. All-optical trans-multiplexing whereby high data rate optical time division multiplexed (OTDM) signals are all-optically converted to lower data rate WDM may therefore become necessary in future photonic gateways which interconnect long-haul OTDM networks to local area WDM networks [1-4]. Previous work on OTDM to WDM trans-multiplexing have included the use of supercontinuum generation and fiber dispersion for a sequential wavelength pulse train (SWPT) [2] or using an optically modulated electroabsortion modulator and fiber dispersion for the SWPT and an all-optical wavelength conversion in dispersion-shifted fiber[3].

In this paper we describe a simple implementation of OTDM to WDM trans-multiplexing using a semiconductor optical amplifier for the wavelength converter and supercontinuum generation and fiber dispersion for the SWPT. The basic operation of the OTDM to WDM trans-multiplexer relies on a four-wavelength pulse train each at 10Gbit/s and interleaved sequentially in time. The four wavelength channels thus combine to produce the SWPT running as a 40GHz clock for the wavelength converter as shown in Fig.1.

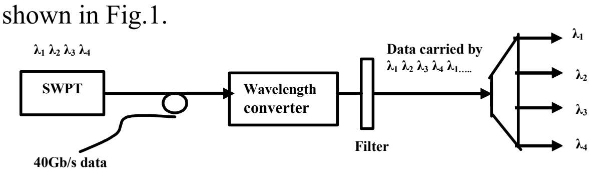

Fig.1 Schematic configuration of the serial-to-parallel conversion

2 Experiment

The setup for 40Gbit/s to 10Gbit/s trasnsmultiplexer is depicted in Fig.2. The fiber laser (Calmar) outputs 10GHz pulses with 1.5ps FWHM and central wavelength at 1558nm. One output is modulated by pseudorandom binary sequence (PRBS) intensity signal (2^{23} -1) generated by 10G BERT and an 40Gbit/s OTDM signal is formed by combining four streams of this data with appropriate delays. The other output is first compressed to increase the spectral width. An arrayed waveguide grating with 200GHz channel spacing and 0.4nm 3dB bandwidth was used to filter out four wavelengths and combine them into a single fiber. The SWPT is formed by using 103m length of high dispersion fiber (DCF has dispersion of -165ps/nm・km) and SMF (single mode fiber,80m,17ps/nm・km) to introduce exactly 25ps delay between neighbor wavelength channels. The SWPT thus forms a 40GHz pulse train. A tunable optical delay line is used to synchronize the 40GHz SWPT with the 40Gbit/s OTDM signal which act as the probe and pump signal respectively in the wavelength converter. The control signal is launched into the SOA in the opposite direction to the probe through a 3-port optical circulator. The average power of the probe and pump signal at the input of the SOA are -10dBm and +3dBm respectively. The SOA (Alcatel 1901) is biased at 190mA and the wavelength conversion is performed by birefringence switching[5]. At the output of the polarizer, a third AWG is used to separate the different WDM channels. The communication signal analyzer (CSA) could analyze waveforms of the output conversion signals. The eye diagrams and pulses are obtained with a 32-GHz photodetector on a 50-GHz-sampling oscilloscope.

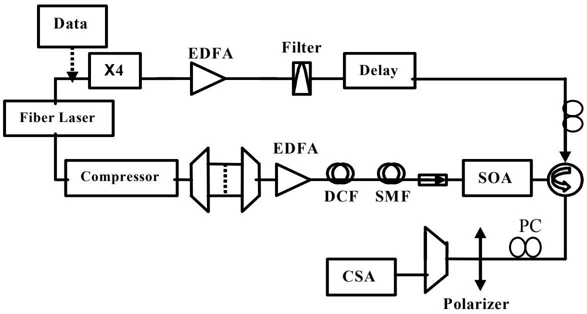

Fig.2 Experiment setup: DCF =dispersion compensating fiber, SMF=single mode fiber, SOA=semiconductor optical amplifier, CSA=communications signal analyzer, PC=polarization controller

3 Results and discussion

Fig.3(a) shows that the four wavelengths pulses are overlap before senting into dispersion fiber and Fig.3(b) shows the four wavelengths pulses are interleaved in time after the dispersion fiber.Fig.4(a) shows the eyediagram of 10Gbit/s signal. Fig.4(b) shows the eyediagram of 40Gbit/s signal which is multiplied from the 10Gbit/s source. Fig.4(c) shows the eyediagram of converted 10Gbit/s signal which is still an opening eyediagram. Fig.5 shows the BER measurement .

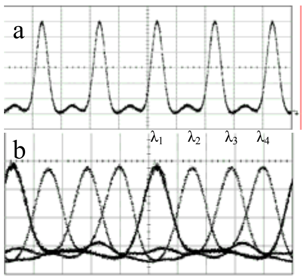

Fig.3 Comparision of (a)undispersed four-wavelength pulses at input of DCF and (b)dispersed four-wavelength pulses at output of SMF

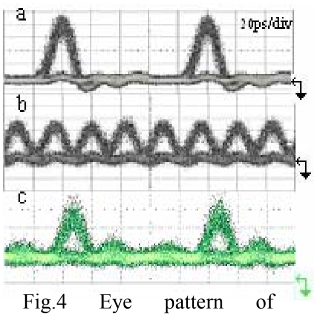

Fig.4 Eye pattern of (a)10Gb/s source(b) 40Gbit/s signal after multiplexer (c) converted 10Gbit/s signal

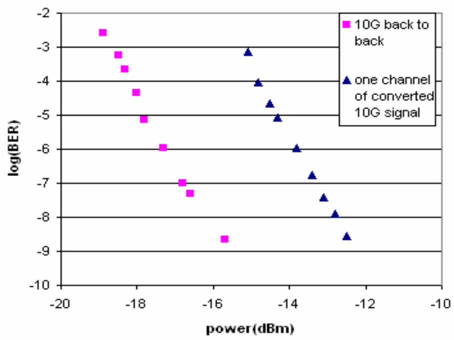

Fig.5 Bit error rate measurement

The power penalty in our experiment mainly comes from the reflected pump light at the SOA facet, which has the same wavelength as the probe light. And it is difficult to precisely determine the polarization state of input probe pulses. We also find that the switching efficiency is not very good for the counter propagation pump structure.

4 Conclusion

A 40Gbit/s to 10Gbit/s signal processing system has been demonstrated based on the serial-to-parallel conversion approach. This system uses four-sequential-wavelength pulse train each operating at 10Gbit/s and interleaved in time to achieve 40Gbit/s serial-to-parallel conversion. We may expect that higher number of converted channels may be obtained using shorter pulse width source and narrower spacing channel AWG. The system enables the high bitrate optical signal to be processed by relatively low cost electronics.

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