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All-optical OOK label Swapping on 33% CRZFSK Payload in Optical Packet Networks

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Abstract. We proposed and investigated superimposing intensity modulated labels onto high speed frequency modulated payloads in optical label switching packet networks. The transmission performance of 2.5Gb/s ASK label on 40Gb/s 33%CRZFSK payload is studied for the first time.

Keywords: optical label switching packet network, orthogonal modulation, dispersion compensation

1. Introduction

Internet protocol (IP)-based data flows have come to dominate the traffic in networks all over the world. Driven by existing applications such as the World Wide Web, e-mail, video conferencing, and E-commerce as well as emerging applications such as telemedicine, remote instrumentation, virtual reality gaming, and video-on-demand, IP traffic will be growing on a phenomenal pace. However, to meet the requirements of future high-bit rate networks, a smaller and more flexible granularity in the form of optical packets is needed and this can be provided by optical packet switching (OPS)[1-2]. OLS is a particular implementation of OPS and is an attractive approach to support low-latency and efficient packet routing for future high-speed optical packet networks. One of the key issues of this approach is the method of coding the optical label onto the packet, as it not only directly determines the structure and the performance of the optical core router but strongly related to the channel bandwidth efficiency and the transmission quality of the packet and label [3]. Application of advanced modulation format or multiplexing technique to optical label switched networks based on various “orthogonal relations” has been intensively investigated to accommodate effectively internet packet data traffic as well as stream based circuit switched services. In-band signaling is one of promising technique in terms of spectral efficiency where payload and label can share their bandwidth. To extract label from payload in identical bandwidth, setting orthogonal modulation formats between label and payload is one solution. A combination of intensity modulation (IM) and frequency shift keying (FSK) is a promising technique for optical label switching in optical packet systems [4]. The merit of this FSK labeling is that an FSK transmitter generates the label information on the optical carrier frequency without affecting its intensity. Simultaneously modulated IM and FSK signals are independently demodulated by using an optical filter, so that the label information can be extract without affecting the payload signal [5-9]. In this technique for the traditional way, payload signals are in IM format, while label information is written by FSK signal, because of the bit rate of FSK relatively low just below 10Gb/s. How to realize high bit rate FSK signal for OLS is a problem need to

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be solved. For this purpose, All-optical OOK label swapping on 40Gb/s 33% CRZFSK payload in optical packet networks is proposed in this paper for the first time.

2. Proposed labeling scheme

Fig.1 shows the transmitter architecture of the OLS network with the proposed labeling scheme. Fig.2(a) is the optical spectrums of two symmetrical beat modes are generated by MZM1, these two modes are input to the phase modulator to undergo DPSK modulation, DPSK optical spectrum can be shown from fig.2(b), and then demodulated to intensity modulation by the subsequent MZDI. The center frequencies of the two beams are 193 THz and 193.1THz so that one beam is at the maximum transmission of the MZDI while the other at the minimum. Therefore the demodulated data streams at the two wavelengths are identical but logically inverted. In this way, a FSK signal with constant optical power is generated (fig.2(c)). Sinusoidally driving an MZM2 at half of the data rate between its transmission minima produces a pulse whenever the drive voltage passes a transmission maximum, this way, duty cycles of 33% RZFSK can be realized (fig.2(d)). 33%CRZFSK signals are typically generated by sinusoidally modulating the phase of a 33%RZFSK signal at the data rate using a separate phase modulator (fig.2(e)). The 40Gb/s optical 33%CRZFSK payload signal was then intensity modulated by a 2.5Gb/s ASK signal to form the ASK label via an optical intensity modulator MZM3; The generated optical packet signal with 33%CRZFSK payload and ASK label was then amplified and sent into a single-mode fiber (SMF) and a matching dispersion compensating fiber (DCF). At the receiver, an optical receiver unit consisting of a PIN photodiode for label detection and a 40Gb/s optical 33%CRZFSK receiver consisting of an optical bandpass filter and a PIN photodiode for payload detection were employed.

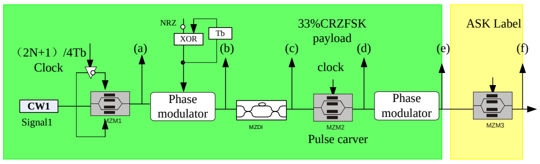

Fig.1. Schematics of the 33%CRZFSK/ASK transmitter.

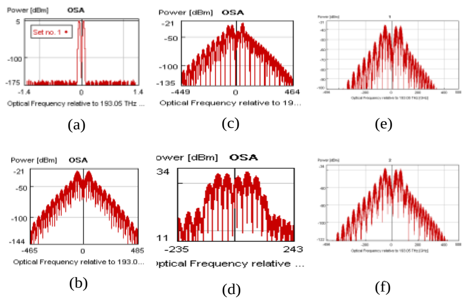

Fig.2. Optical spectrums for the figure 1

3. Simulation demostration

FSK/ASK orthogonal labeling scheme was investigated, by lowering extinction ratio of the ASK modulation. However in these FSK or PSK/ASK schemes, critical adjustment for the extinction ratio is required to obtain balanced signal quality of both payload and label [8]. We simulated the Q value for payload and label under the different extinction ratio of ASK modulator, it can be seen from the fig.3 that the Q value of payload is gradually decreased and label increased while extinction ratio is increased and the extinction ratio 1dB for ASK modulator is adopted for the simulation.

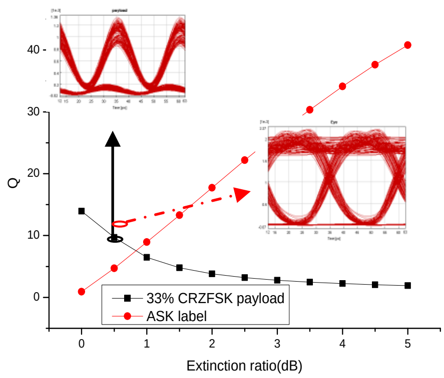

Fig.3. Q performance under different extinction ratio of MZM3

We investigated transmission characteristics of payload and signal under varying fiber length consisting of standard single mode fiber (SMF) compensated by dispersion compensation fiber (DCF) for proposed signals.

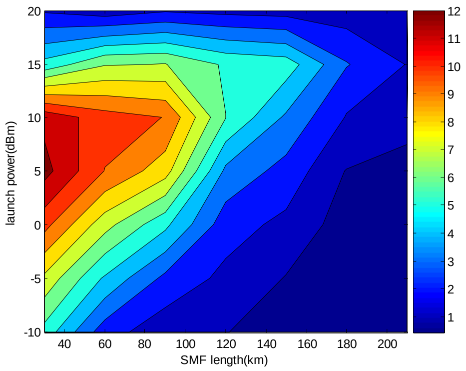

Figure 4. Performance of ASK label under post compensation scheme

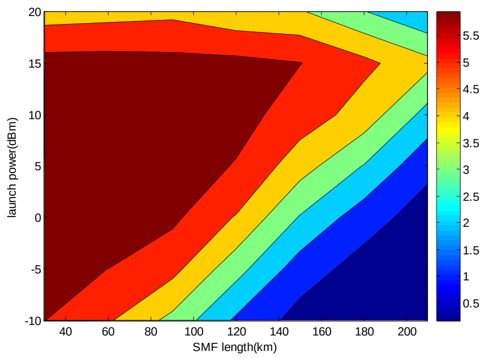

Figure 5. Performance of 33%CRZFSK payload under post compensation scheme

It can be shown from fig.4-5 that optimum launch power for proposed scheme is 10dBm with extinction ratio of ASK modulator is 1 dB under post–compensation scheme. For the same transmission distance, the Q performance of payload and label became maximum and then gradually became small while increasing the launch power, and the SMF length can reach 120km for one span.

4. Conclusion

A novel all-optical 2.5Gb/s ASK label swapping on 40Gb/s 33%CRZFSK payload scheme in optical packet networks is proposed in this paper. We studied the transmission performance of payload and label signals under post compensation scheme. It suggests that 33%CRZFSK modulation scheme could be a promising candidate for future high-speed transmission system and optical label switching networks.

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