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Novel optical packet switching scheme using OFDM label with one core router and two edge routers

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ABSTRACT

In this paper, we propose and experimentally demonstrate a novel optical packet switching scheme with one core router and two edge routers, in which an orthogonal frequency division multiplexing (OFDM) signal is generated as a label. In this experiment there are two transmission spans, each span consists of 50-km SMF-28 and an erbium-doped optical fiber amplifier (EDFA) without dispersion management. A 10 Gb/s on-off keying (OOK) optical payload and a 2.5 Gb/s OFDM optical label are generated, encapsulated, and transmitted in the first span. And then old label is replaced by new label, the generated new optical packet after transmission over the second span is detached and detected. The transmission performance of the optical label and payload is experimentally investigated at the ingress router, core router and egress router.

1. Introduction

Optical packet switching (OPS) is recently attracting much research attention because it is considered to be one of the most promising solutions for the transportation of high bit-rate data across optical networks of the future [1–7]. Optical label switching (OLS) is an important aspect of OPS and it involves the extraction and processing of the labels, so that the packets can be used to route and forward in high-speed networks independently of IP packet length and payload bit rate [8]. Recently, orthogonal frequency division multiplexing (OFDM) technology has become one of the most promising methods in different optical communication systems since it has high spectral efficiency and the resistance to various dispersion effects including chromatic dispersion (CD) and polarization mode dispersion (PMD) [9]. In this paper, we experimentally realize generation and transmission of OFDM label at 2.5 Gb/s and OOK payload at 10 Gb/s based on independent modulation of label and payload, and so further demonstrate that OFDM labeling is a feasible solution in optical label switching networks. We also show an optical label switching network experiment with three routers including ingress router, core router and egress router.

2. Generation and detection of OFDM label and OOK payload

The principle of our proposed scheme setup for generation of OFDM labeled packet with OFDM label is shown in Fig. 1(a). The wavelengths ($\lambda_1$andλ_2) of two continuous-wave (CW) lasers are carefully selected so that one beam (λ_1) is modulated by OFDM label signal at low bit rate in the modulator$_1$, and the other (λ_2) is generated to drive the modulator$_2$ which is modulated by OOK payload at a higher bit rate. After the optical label and payload at two wavelengths are independently generated by two external modulators (modulator$_1$ and modulator$_2$), they are combined by an interleaver and inputted to the fiber link. At the receiver, one interleaver is used to separate OFDM label and OOK payload. The demultiplexed label and payload are received and their clocks are recovered by two individual commercial receivers. Especially for optical OFDM label, the system configuration extensively relies on digital signal processing (DSP), such as fast Fourier transform (FFT), inverted FFT (IFFT), guard interval and cyclic extension, channel equalization, synchronization, analog-to-digital and digital-to-analog conversions (ADC and DAC). In our scheme, the OFDM label receiver also involves extra signal processing, usually including phase estimation and polarization diversity detection.

This method has several advantages. First, OFDM label modulation has higher spectral efficiency (SE) and narrow spectrum than regular nonreturn-to-zero (NRZ) or return-to-zero (RZ) optical label. Second, the OCSS technique suffers no ER limitation for the OOK payload. Third, the implemented OFDM label bit rate could be chosen and operated at any bit rate. The only requirement is

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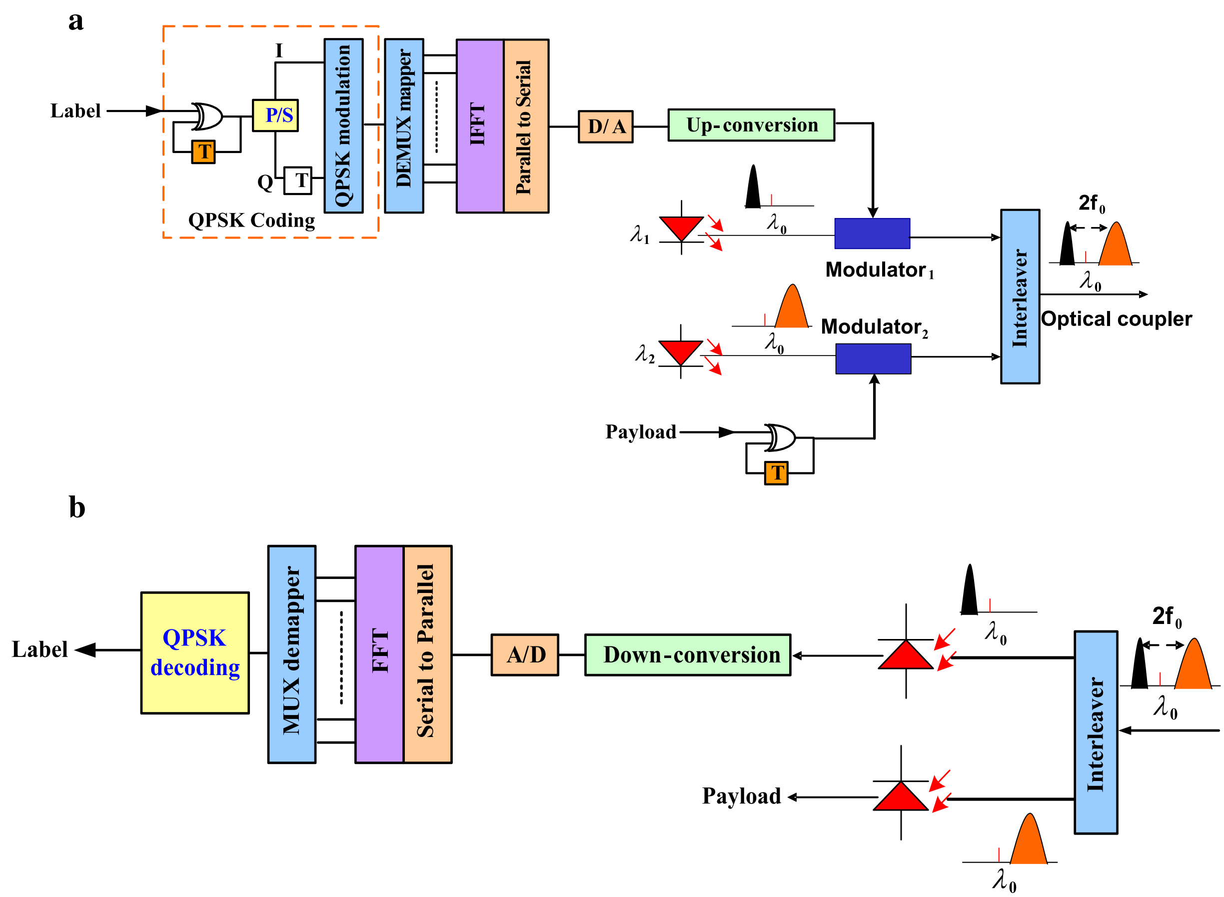

Fig. 1. (a) Optical packet generation at the ingress node, (b) optical packet detection at the egress node.

that the label bit rate must be less than or equal to the wavelength spacing of two CW lasers. Fourth, because of the wide wavelength spacing between the two CW lasers, the label and the payload are much easier to separate with optical filtering. Fifth, the payload and label can be separately generated and there is no crosstalk between the label and the payload.

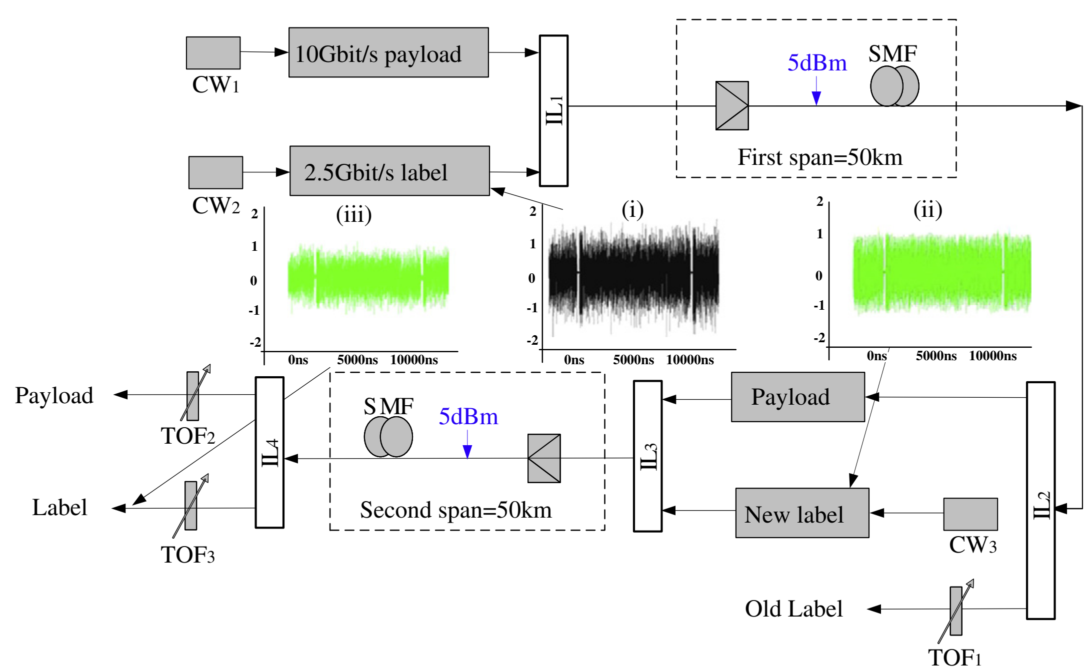

Fig. 2. Experimental setup, (i)–(iii) shows the measured electrical waveform of the old label and new label in three routers.