1×N All-optical packet switch at 10 Gb/s

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Abstract: We demonstrated a 1×N all-optical packet switch with all-optical header processing and packet switching at 10 Gb/s using multi-wavelength mutual injection-locking in a single Fabry-Pérot laser diode. The packet header is processed at 10 Gb/s.

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1. Introduction

All-optical packet switching in which both header processing and packet switching are carried out in the optical domain eliminate the need for optical-electrical conversion and are expected to play an important role in future high speed networks. Recently a 1×2 all-optical switch was implemented using a semiconductor laser amplifier in optical loop mirror (SLALOM) structure and an optical flip-flop memory [1]. The payload data rate is 2.5 Gb/s and the payload must be Manchester-encoded. The header data rate is slower and the header is in the order of microseconds long. In this paper, we demonstrated a 1×N all-optical packet switch using multi-wavelength mutual injection locking in a single Fabry-Pérot laser diode (FP-LD). The data rates of both the header and payload are 10 Gb/s and no special encoding format is required for the payload.

2. Operating principle

The proposed all-optical packet switch implemented a recently proposed self-routing address in which each output port of every node in a network is identified by the location of a single bit in the address header [2]. For example, Fig. 1a shows two data packets at wavelength \( \lambda_d \) with address headers ‘1000’ and ‘0100’ intending for output port 1 and 2 respectively of a node. Figure 1b shows the local control packets at wavelength \( \lambda_c \) used for header processing at output port 2. The address of the control packet is the complement of address of port 2, i.e. ‘1011.’ The data packet and control packet are injected simultaneously into an FP-LD for all-optical header processing and packet switching.

If the address header of a data packet does not match with that of the local control packet, the control packet will injection-lock the FP-LD at \( \lambda_c \). The resulting red-shift of the FP-LD mode comb suppresses the data signal gain at \( \lambda_d \) [3]. As a result the FP-LD blocks the data packet. If the address of a data packet matches with that of the control packet, the data packet injection-locks the FP-LD such that the output of the FP-LD at \( \lambda_d \) will be high while that at \( \lambda_c \) will be low. Thus the FP-LD transmits the data packet. Figures 1c and 1d show the output of the FP-LD at wavelengths \( \lambda_c \) and \( \lambda_d \) when the address of the data packet matches and does not match with that of the control packet.

3. Experimental results

Figure 2 shows the experimental setup. The packet header is 4 bits long corresponding to the header for a 1×4 switch. The data packet payload and the guard period are 1,262 and 14 bits long. Figures 1e and 1f show the timing diagrams of the control packet headers and the data packet headers for the 4 different data packets respectively. Figures 3a and 3b show the timing diagrams of the data packets and control packets at the input of the FP-LD. Figure 3c shows the guard period and the header of the control packet. Figures 3d and 3e show the output of the FP-LD at the wavelengths of the control signal and data signal respectively. The FP-LD only transmits the data packets with headers that match with that of the control packets.

4. Conclusions
We have demonstrated all-optical packet switching using a single FP-LD. A simple self-routing address is used to encode the packet addresses. The data rates of both the header and the payload are at 10 Gb/s.

5. References


Fig. 1 The time domain all-optical heading processing, packet switching mechanism, and relative temporal profiles of the control packet headers and four consecutive data packet headers at the FP-LD input. (200 ps/div)

Fig. 3 Measured timing diagrams for (a) the 10Gb/s input data in sequence of 4 packets (pk), (b) the input control signal and (c) the control packet header (‘1011’) before packet processing; (d) the output control packets and (e) the switched data packets.