Photonic subsystems for optical packet/burst switches based on heterogeneous SOI and III-V integration

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Abstract: In this paper we describe how high-quality silicon photonic ICs and III-V membrane switches integrated on this platform can be used to build photonic subsystems for optical packet switches.

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1. Introduction

The quality of passive optical devices fabricated in high index contrast silicon waveguide platforms has improved steadily over the last years. Low loss (<1dB/cm for rib waveguides, <0.15dB/cm for ridge waveguides [1]), highly wavelength selective filters (Q>0.5Million [2]) and good AWG demultiplexers (crosstalk > 25dB [3]) are all available now. In addition using our well established III-V on silicon heterogeneous integration platform we demonstrated optical switches with high extinction ratio. Together these functionalities allow realizing several of the building blocks required for complex optical packet switches on a very compact footprint.

2. Optical label extractor

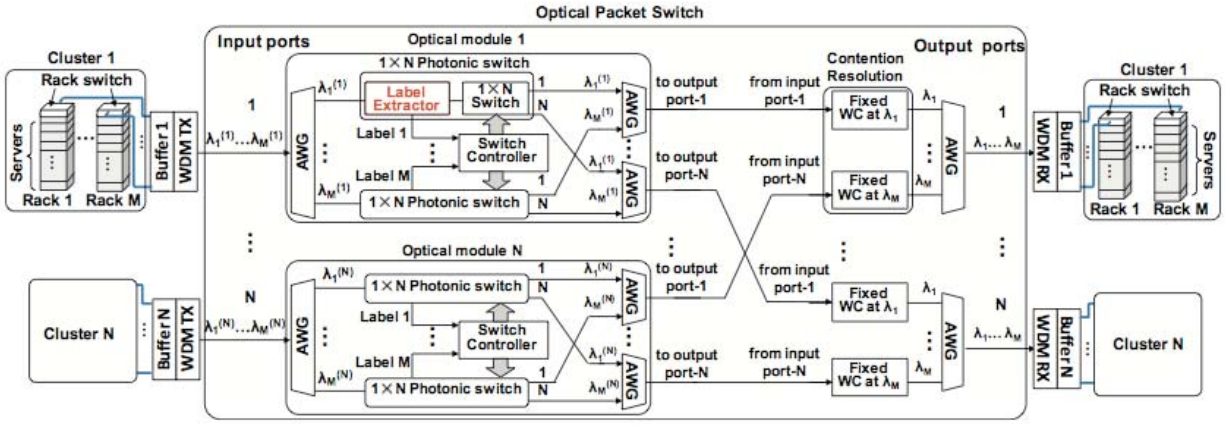

Fig. 1 Example of a modular WDM optical packet switch architecture (from [4])

Fig. 1 shows the schematic of a proposed optical packet switch [4]. An important building block within this switch is the optical label extractor, which separates the narrowband labels determining the packet address from the payload. We successfully demonstrated such a label extractor using a chip consisting of 4 cascaded high-Q ring resonators [5]. Fig. 2a shows the spectrum of the packet arriving at the label extractor, including a 160GBit/s modulated packet and 4 narrowband labels encoded within the band. Fig. 2b shows the superimposed spectra of the 4 labels after passing through the label extractor shown in Fig. 2c. Extensive bit error measurements were carried out on the labels as well as on the transmitted payload.

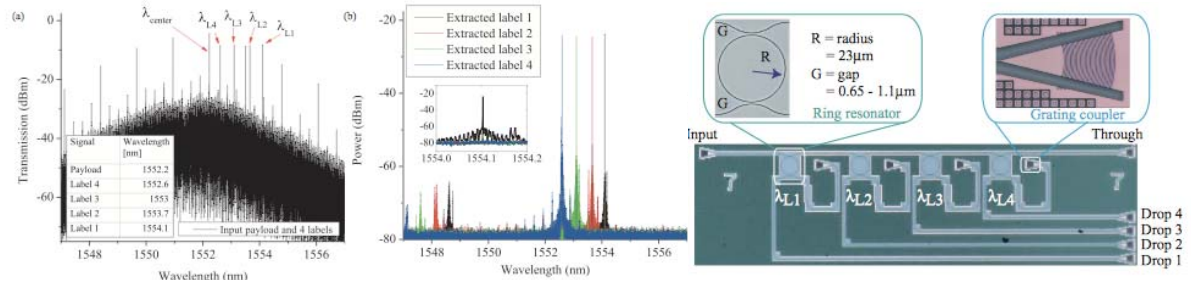

Fig. 2 (a) Optical spectra at the input spectrum of the label extractor consisting of a 160 Gb/s modulated payload signal centered at 1552.2 nm and four 1.3 Gb/s modulated label signals. (b) the output spectra of the four labels measured at the drop ports of the label extractor shown in (c). (taken from [5])

3. MIPS: Membrane InP swich

Using our III-V on silicon heterogeneous integration platform we developed switches with high performance. As shown in Fig. 3a,b these switches consist of a thin InP membrane containing 3 InGaAsP quantum wells bonded on an SOI platform [10][9][8]. In the off condition this device is highly absorbing in the wavelength range 1530nm-1570nm. However, when pumped with an optical beam the switches become transparent Fig. 3c. The high optical confinement in the InP membrane thereby strongly reduces the required pump power.

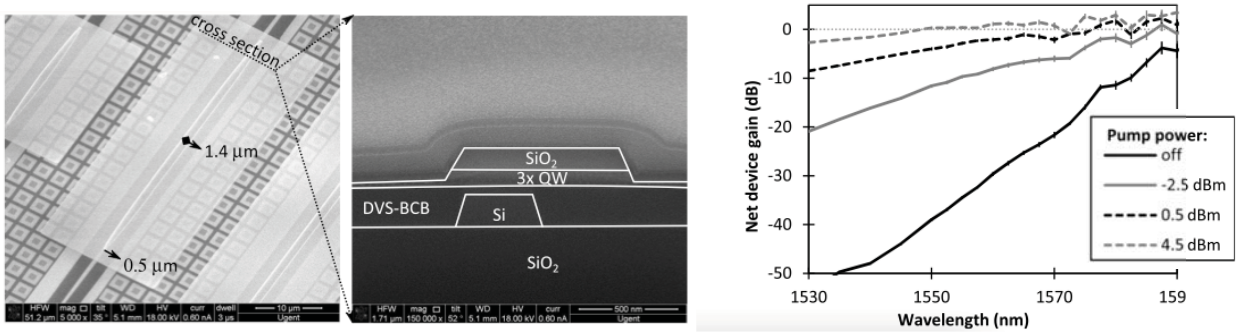

Fig. 3 a) Top view of InP Membrane Switch. b) Cross-section. c) Transmission when optically pumped (from [8])

Next we integrated these Membrane InP Switches (MIPS) into a 1 x 4 network containing splitters and a wavelength selective AWG as shown in Fig. 4a. Through choice of the wavelength of the pump beam 1 of the 4 MIPS is selected and pumped to transparency, while the other paths remain blocked [6][7]. Fig. 4b shows the transmission of two packets through the system (with the packet in between the two packets transmitted being blocked).

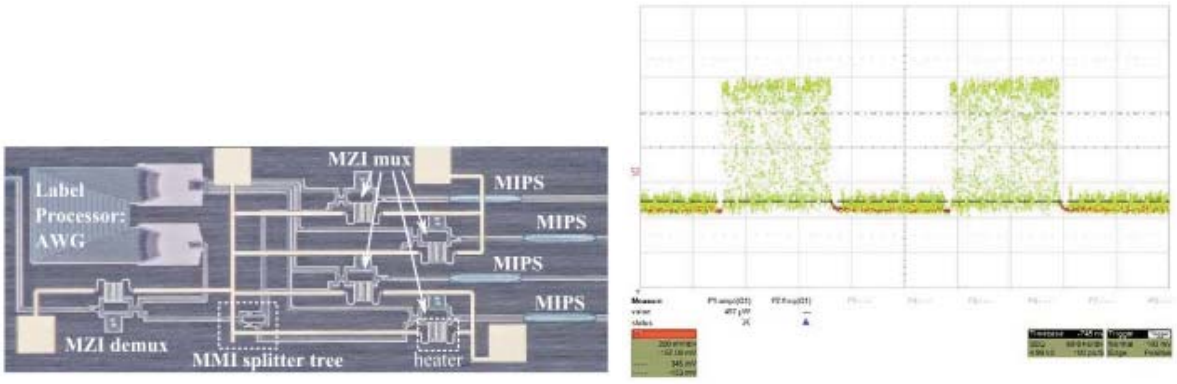

Fig. 4 a) Top view of 1x4 MIPS powered switch. b) Detected data signal at the AC receiver. One out of two packets is being blocked by the MIPS. (from [6])

4. Acknowledgements

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5. References

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