Silicon photonic interconnection networks in high performance datacom systems

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***Abstract* - We propose highly scalable, low footprint optical network elements based on silicon photonic microring resonators with nanosecond switching times.**

I. INTRODUCTION

Driven by the increased proliferation of cloud computing and big data applications, the demands on high performance Datacom systems for computing and storage continue to grow. High performance Datacom systems are envisioned to reach exascale dimensions [1] which will require highly scalable and energy efficient means for data exchange. Optical data movement is one of the promising means to address the bandwidth demands of these systems. So far optical links are being increasingly deployed in data centers and high-performance computers but to facilitate the increase bandwidth demand and provide flexibility and high link utilization, wavelength routing and optical switching is necessary. The basic optical network elements to realize these functionalities are wavelength selective switches (WSS), spatial switches or optical cross-connects (OXC) and reconfigurable add/drop multiplexors (ROADM). These elements should be capable of handling large amount of data, densely multiplexed multiple wavelengths and offer fast re-configurability in order to achieve nanoseconds switching times.

Silicon photonics have been proposed as an excellent candidate to realize low cost, energy efficient, low footprint optical network components. The basic silicon photonic elements are the Mach-Zehnder interferometer and the microring resonator. The microring in particular has been shown to be able to act as 1x2 and 2x2 nanosecond switch [2], as a modulator and as a wavelength filter. Scalability is achieved by integrating multiple of these elements on a single chip [3] which due to the CMOS process compatibility can be done at essentially no extra cost. Significant research efforts have been extended on the design of various integrated on-chip architectures. So far many different integrated silicon photonic devices performing different networking functionalities have proposed and fabricated.

II. SILICON PHOTONIC MICRORING-BASED OPTICAL NETWORK ELEMNTS

In this work we propose network elements designs based on actively controlled silicon microrings. The proposed architecture for an OXC consisting of a wavelength selective filter on the input, microring based switch fabric and a microring based multiplexor at each output port is shown on figure 1a). The ROADM architecture is shown on figure 1b). Experimental results on a fabricated device with this design showed little signal distortion and open eye diagrams for simultaneously performing same wavelength add/drop as indicated on the figure. By meticulously analyzing the losses, cross talk and power penalties we have derived the optimal values for the microring parameters. Analytical modeling and simulations showed that the proposed architectures are highly scalable.

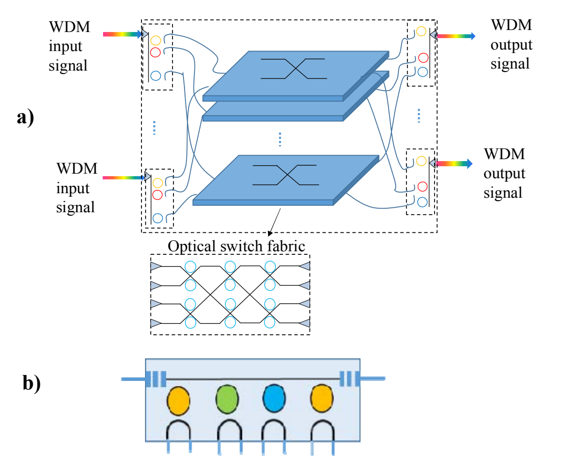

Fig. 1 a) OXC architecture with microring based wavelength selective filters at the input, spatial switches and multiplexors **b)** ROADM device architecture with microrings.

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