A free-space optoelectronic crossbar interconnect with Terabit/s communication to silicon electronics

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ABSTRACT

A high data-rate free-space optoelectronic crossbar system designed to demonstrate 1 Tbit/s communication to silicon CMOS is described. The interconnect is based around a hybrid InGaAs-based smart-pixel chip and features vertical cavity surface-emitting laser input.

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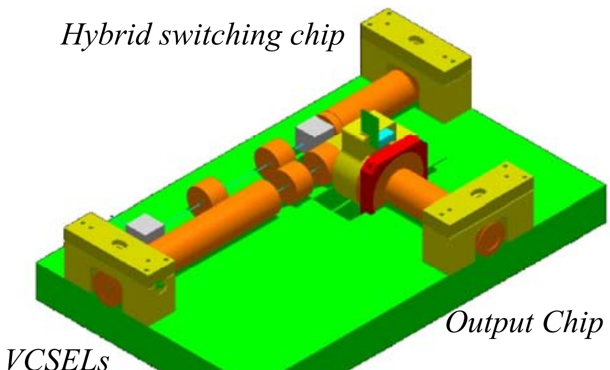
It has been observed that the fundamental physical limit on communication rates between silicon CMOS chips may be lower than 1 THz for conventional metal lines of lengths ~ 10cm. This bandwidth limit scales as the aspect ratio (the ratio of total cross-sectional area to length) of the interconnect[1]. Since the off-chip bandwidth requirement of silicon ASICs is predicted to increase beyond 1 THz within five years, a potential bottleneck in computational performance can be foreseen. Free space optoelectronic connections show promise in overcoming the predicted bottleneck since they offer high spatial density connections (>10^6 per cm^2) free of the aspect-ratio problem and many other limitations of electrical interconnections[2].

The Smart Pixel Opto-Electronic Connections (SPOEC) project addresses the requirement for high data-rate i/o to Si-CMOS by the demonstration of free-space optical connections to and from an optoelectronic crossbar chip at aggregate bandwidths in excess of 1 Tbit/s. The demonstrator (see Figure, right) is constructed around a hybrid InGaAs-based chip, solder-bump bonded onto a silicon CMOS routing chip. The electrical input to the demonstrator (64 channels at 250Mbit/s per channel) drives an 8x8 array of 960nm wavelength, 10µm diameter VCSELs. These signals are fanned-out and imaged on to the detectors of the hybrid switching chip (at an aggregate data rate of 1Tbit/s). Output of the routed data is achieved by the reading of differential pairs of multiple quantum well modulators on the switching chip by a Nd:YLF laser. These data streams are imaged onto an output chip. The routing of the two different wavelength input and output signals is performed by custom designed thin-film beamsplitters.



<u>*Schematic of the SPOEC crossbar system*</u>

Results will be presented from individual component experiments and initial tests of the SPOEC crossbar assembly.

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[1] DAB Miller and HM Ozaktas *J. Parallel Dist. Computing* **41**(1) p. 42-52 (1997)

[2] See, for example, David T. Neilson et al, *Appl. Opt.* **36**(35) pp. 9243-9252 (1997) and references therein.