Holographic switch for data center

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Data centers are responsible for 2% of the electrical consumption in the United State.[1] This power consumption is increasing at the same rate as the IP traffic which is exponential.[2] The industry sector is very well aware of this unsustainable trend, and new innovations are constantly funneled from the laboratory into the real world to curb this progression. Among the power hungry equipments of data centers are the electronic switches that redirect the signal from server to server. These switch are needed in order to collect the information scattered among servers and to send it to its final destination.

Inside an optical fiber, the information propagates freely in the form of a photon, but each time this photon needs to be redirected (switched), it is transformed back into electricity. So, inside the electronic switch the photon is converted into an electric current, analyzed, and a new laser is turned on at the emission end of another transmission fiber. Each of these operations are costly in term of electrical consumption and could easily be replaced by a simple mirror redirecting the initial beam of light. No electrical transformation is necessary. This is precisely what a new generation of switches is doing: optical switching with micro-electro mechanical mirrors (MEMS). However the present capability of these 3D optical MEMS is limited by their slow reconfiguration speed which is of the order of a few microsecond. Microseconds are orders of magnitude larger than the GHz speed at which the traffic is transmitted in optical fibers. Therefor the 3D MEMS optical switch are only used for provisioning, and do not impact energy consumption of the data center as it was promised.

Our unique approaches is to use diffraction from the micro mirror array instead of reflection. In the case of diffraction, the size of the micro-mirrors can be reduced by a factor of 10,000 and so their reconfiguration speed can be increased by the same factor.[3] We are using a Texas Instrument DLP to display holographic computed patterns that redirects the light from fiber to fiber. The reconfiguration speed of the DLP is only a few microsecond which is much faster than with other optical switch. Other advantages include the possibility of multicasting, and signal aggregation which are not feasible with 3D MEMS.

We have already build several proof of concept demonstrators of that new type of switch.[4] The performances have been monitored with an Internet traffic simulator and showed that the switch behave as expected. A demonstrator has been successfully implemented in a new type of data center architecture to take full advantage of the reconfigurability.[5]

We are working on a new type of phase MEMS which will be at the core of the new holographic switch. This phase MEMS will be faster and more efficient that what is existing on the market today.

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1 Shehabi, Arman, et al. "United States data center energy usage report." *Lawrence Berkeley National Laboratory, Berkeley, California. LBNL-1005775 Page* 4 (2016).

2 CISCO. Cisco Global Cloud Index: Forecast and Methodology, 2015–2020; Technical Report; CISCO: San Jose, CA, USA, (2016).

3 P.-A. Blanche et al., “Diffraction-Based Optical Switching with MEMS“, MDPI Applied Sciences, *7*(4), 411 (2017).

4 P.-A. Blanche et al., “Fast Non-blocking NxN Optical Switch Using Diffractive MOEMS”, invited talk in Optical Fiber Communication Conference, Los Angeles, California, March, 2015

5 Ghobadi, Monia, et al. “Projector: Agile reconfigurable data center interconnect.” *Proceedings of the 2016 conference on ACM SIGCOMM 2016 Conference*. ACM, 2016.

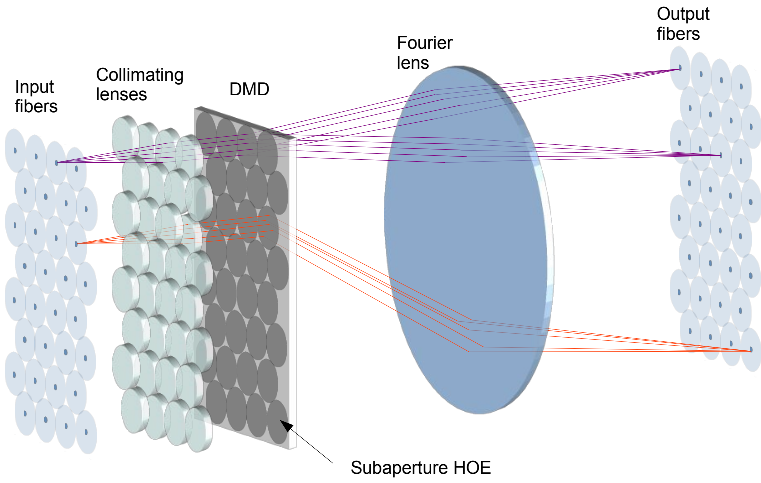

Figure 1: Schematic of the holographic switch configuration.

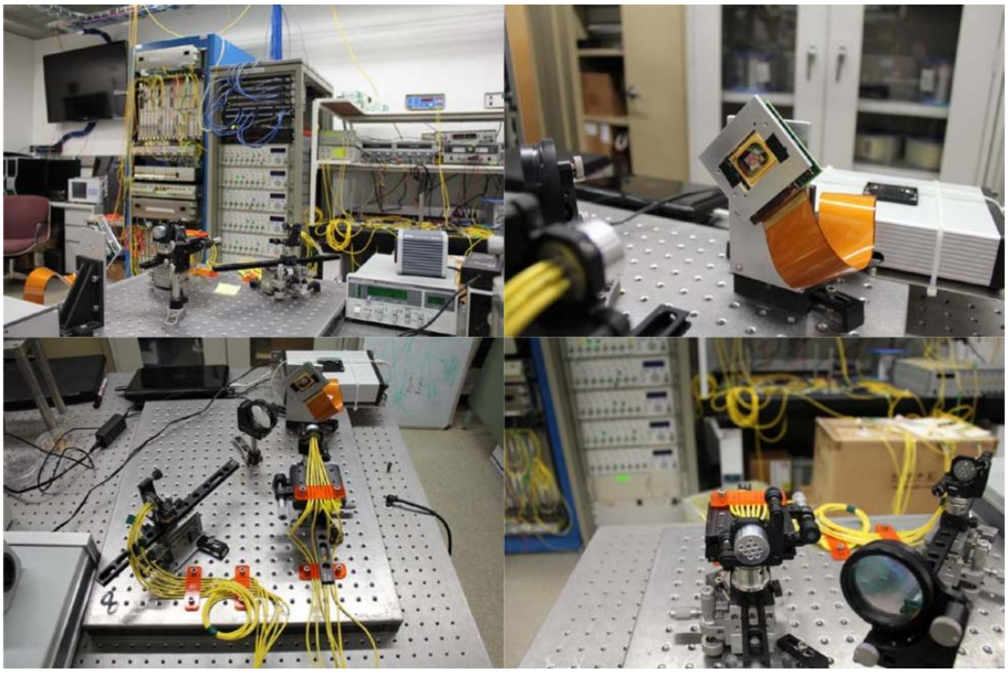

Figure 2: The holographic MEMS prototype being tested in the Internet traffic simulator lab.

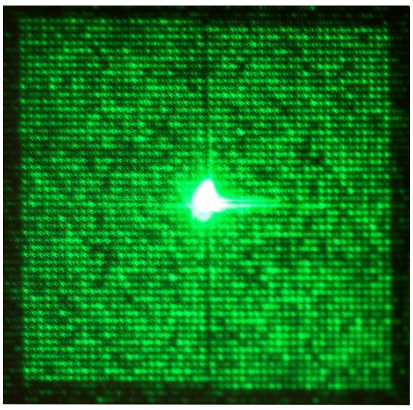

Figure 3: Generation of an array of a large number of points with the holographic switch showing the multicasting capability. Model shows the possibility for up to 10,000 output ports