**Breaking the Boundary between Optical Communication and Optical Computing**

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**Abstract:** The evolution of the human computing power has never stopped, however, the observed pace of the semiconductor industry is notably slowing down especially since the 14 nm technology node transistors. This is driven by physical limitations in the information processing units, as one part of the computing power, relating to leakage current, on-chip power budget, thermal dissipation density, and non-circumventable fabrication process control. With the electronic computing system become more constrained by the aforementioned limitations, optical replacements have been demonstrated recently in both data processing and communication with the potential of breaking through the electronic energy barrier with wavelength division multiplexing (WDM).

We break down the problem into three parts: 1) adapting hybrid photonic-plasmonic technology into fundamental computing engines; 2) building hybrid photonic-plasmonic on-chip communication networks components such as interconnects, routers and transceivers with mutual capability; 3) applying the computing unit to the on-chip optical networks and finding a holistic figure-of-merit (FOM) for overall performance evaluation among different technologies as well as using it as a guideline for system reconfiguration.

Here we demonstrate a prototype of a complete optical computing system solution from the logic devices and problem solvers to network related routing components and fundamental on-chip network applications. We show the benefit of keeping the data signals within optical domain during the whole system with over an order of magnitude energy efficiency improvement and the ability to dynamically reconfigure based on the traffic patterns and applications. Moreover, by hybridizing the photonics with plasmonics, these hybridized devices integrated on-chip effectively connect the optical logics to the optical network which tend to mitigate the power and heat dissipation challenges, and even extending data bandwidth with the potential of breaking through the electronic energy barrier with the unique parallelism feature of light.