The photonic alternative to microelectronic chips

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Notwithstanding the juggernaut of silicon microelectronics, time is opportune to consider the prospects of future photonic systems on the chip-scale. Lightwave technology has now induced its own form of communication revolution, largely because of the high bandwidth replacement of electrical transmission systems, one future consequence of which maybe globally distributed information processing. On the chip-scale, however, the concept of a photonic information processor has not made significant inroads into the domain dominated by VLSI microelectronics.

If we start with the premise that bandwidth is (almost) everything, whereas device density, albeit important, is not, there is good reason to consider the future of ultrahigh speed (>100 GHz), all-photonic, chip-scale or nearly chip-scale, information and communication processors. Some prospective component-level building blocks are becoming available through the present efforts to develop ever faster fiber communication systems, such as ultra-low-threshold vertical cavity lasers, relatively energy-efficient optical switches, subwavelength diffractive optical elements, and so on. Additionally, the intersection of photonic technology with nanoscience is offering the prospect of entirely new classes of optical materials for chip-scale functions, for example, where the coupling of light with electronic degrees of freedom exceeds the usual weak perturbation regime typical of all existing photonic devices. In this talk, ongoing research and recent advances are used to argue that chip-scale photonics is an idea whose time is coming.