Microphotonics for Next Generation Computers

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Future high performance computers will be limited by the performance of communications in the computer networks, memory subsystems, and perhaps even within microprocessors themselves. Already, it is clear that within massively parallel high performance computers, the communications paradigm must change. While microprocessors continue to benefit from Moore's Law scaling of transistor performance, no Moore's Law exists for communications. As a result, communications efficiency in terms of energy/bit has remained largely flat over the past decade. Left unchecked, the fraction of power consumed by the computer network will begin to dominate the machine power. Moreover, the use of serial electrical and optical links has led to bottlenecks in pin density and wire/fiber count. These bottlenecks are being felt not only in the computer network, but also in the memory, processor, and network switch subsystems. Recently, silicon microphotonics has demonstrated the ability to significantly improve communications efficiency while dramatically increasing communications density through the use of wavelength division multiplexing. Here, we review approaches for modulation, filtering, switching, and detection in a silicon photonics platform, highlighting recent results along with the many challenges that remain to implement a stable low-power wavelength division multiplexed silicon microphotonics platform.

Michael R. Watts, is an Assistant Professor leading the Photonic Microsystems Group at the Massachusetts Institute of Technology. Professor Watts received his BS in Electrical Engineering from Tufts University in 1996. From 1996 to 1999 he was a Member of Technical Staff in the Fiber Optics Group at the Charles Stark Draper Laboratory. From 1999 to 2001 he was a Draper Fellow and received his SM and PhD degrees in Electrical Engineering from MIT in 2001 and 2005, respectively, where he designed and demonstrated the first polarization independent microphotonic circuit. In 2005, he joined Sandia National Labs where he led their silicon photonics development effort as a Principal Member of Technical Staff. Prof. Watts has authored or co-authored over 50 conference and journal publications, several invited talks and papers, two book chapters, and nine U.S. patents. In 2009 Prof. Watts was honored with an R&D100 award for his work in ultralow power silicon microphotonic modulators and high-speed bandpass switches.