Grand Challenges and Timelines for Electronic-Photonic Integration

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Abstract

Transistor dimensional shrink enabled constant-cost performance scaling of integrated circuit chip performance at a rate of 100x/10yr. During the same period, interconnection proliferation among distributed resources has enabled computation system performance to scale at a rate of 1000x/10yr. Interconnection is now the scaling paradigm for chips and subsystems, and bandwidth density is the new shrink metric. Photonic interconnects are dominant in telecommunication networks, and they have successfully penetrated both data center and HPC rack-to-rack interconnection. In general, the transition from electronic to photonic interconnection occurs at a single-channel bandwidth x distance product of 1-3 Tb/s cm (BxD = 1-3 Tb/s cm). In 2017 single-channel bandwidth (B) will cross 400Gb/s threshold for board-level distances of >10cm. Board-level optical interconnection will require high volume manufacturing solutions with minimal impact on system cost. Package-level, intra-module photonic interconnection for distances of >1cm are forecast for ~2020 with data rates of 1-3Tb/s. Photonic interconnect solutions can meet system requirements for power and bandwidth density, but they have not yet met the cost point for pervasive intra-system deployment. Silicon photonics is being universally adopted to establish a 'future proof' platform that can achieve 'learning curve' cost reduction with cumulative production. Highlights of the recently released Integrated Photonics System Roadmap (IPSR 2016) will provide the context for discussion of the silicon photonics hardware platform, its architectural evolution over the next two decades and its monolithic integration with electronics for the next scaling paradigm.

Biography

Lionel C. Kimerling is the Thomas Lord Professor of Materials Science and Engineering at MIT. He is the AIM Photonics Institute Executive for Education, Workforce Development and Roadmap. He is the founding Director of the MIT Microphotonics Center where he conducts an active research program in the design and processing of semiconductor materials and devices. He was Head of the Materials Physics Research Department at AT&T Bell Laboratories, when he joined the faculty of MIT as Professor in 1990. He has authored more than 400 technical articles and more than 75 patents. Kimerling is the recipient of the 1995 Electronics Division Award of the Electrochemical Society and the 1999 John Bardeen Award of TMS. He is a Fellow of the American Physical Society, the AAAS, TMS, MRS and the School of Engineering, University of Tokyo. His research teams have enabled long-lived telecommunications lasers, developed semiconductor diagnostic methods such as DLTS, SEM-EBIC and RF-PCD, and pioneered silicon microphotonics.