Control layer: Electronics at service of photonics

Francesco Morichetti

1. *Dipartimento di Elettronica, Informazione e Bioingegneria, Politecnico di Milano, via Ponzio 34/5, 20133, Milano*
e-mail: francesco.morichetti@polimi.it

State-of-the-art photonic integrated technologies enable to miniaturize optical devices in such a way that many different optical functions can be potentially implemented in a small area photonic chip. However, when many photonic devices are aggregated into complex photonic integrated circuits (PICs), fabrication tolerances, thermal fluctuations, and mutual crosstalk effects become critical, and advanced tools are required to reliably set and hold the desired working point of the system [1].
An electronic layer keeping photonics under control is particularly needed when dealing with wavelength selective devices, such as microrings resonators, with flexible and reconfigurable architectures, and/or with semiconductor photonic platforms, such as silicon on insulator (SOI) or indium phosphide (InP), because of the high sensitivity of these materials to temperature variation.
In this lecture, the main issues related to the control of PICs are addressed, overviewing the main approaches to implement the three key functions of any feedback controlled PIC (see Fig. 1): identification of the current working point (*on-chip light monitors*), working point manipulation (*amplitude/phase integrated actuators*), automated (re)configuration and stabilization of the PIC (*control and calibration algorithms*). Fundamental aspects will be discussed in details, including the technological challenges posed by the realization of non-perturbative, high-sensitivity integrated light monitors; the implementation of compact and energy-saving actuators; accuracy, robustness, speed and power consumption of the control loop; issues related to the monolithic/hybrid integration of the photonic and electronic layers.

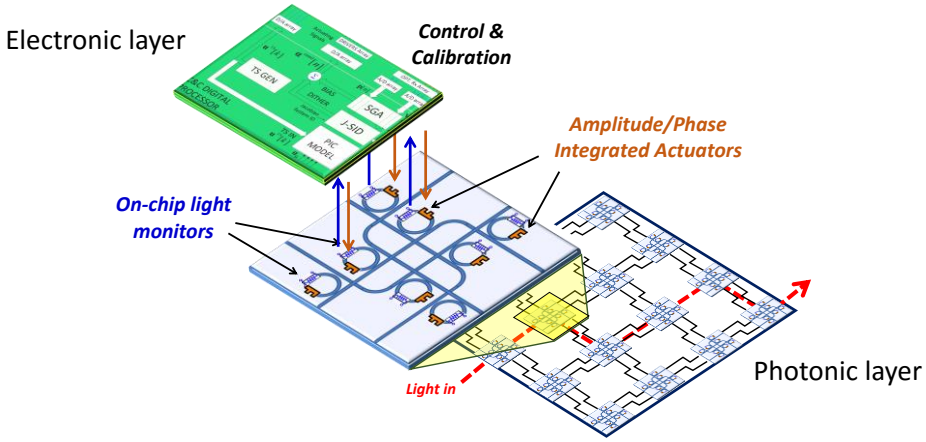

Figure 1. Schematic view of a feedback-controlled PIC: the electronic layer monitors the PIC though on-chip light monitors and manipulates/stabilizes the PIC working point through integrated actuators according to dedicated control and calibration algorithms.

References

[1] F. Morichetti, S. Grillanda and A. Melloni, "Breakthroughs in Photonics 2013: Toward Feedback-Controlled Integrated Photonics," in IEEE Photonics Journal, vol. 6, no. 2, pp. 1-6, April 2014.

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