







Figure 2: Technology stack for programmable photonic circuits. Apart from the photonic and electronic chip, connected with packaging technology, there is a need for multiple layers of driver, control, configuration algorithms and programming tools.

Of course, a first requirement is that this technology becomes available. To realize the promise of such programmable photonic chips, the entire technology stack must be accessible to the users [5]. Like application-specific photonic circuits this requires a photonic chip, but also the electronic drivers, fiber connections and packaging technologies (including high-speed electronics if needed). But on top of that, programmable photonics needs additional software layers, starting with low-level management of the individual actuators and detectors in the circuit, to control and calibration routines (all elements in these circuits are analog and susceptible to fabrication variations). Users of these programmable chips will need synthesis algorithms to implement custom functionality such as wavelength filters, and define connectivity between building blocks and subcircuits (similar to placement and routing in electronic FPGAs). Also, like with programmable electronics, these design activities should be supported by a solid development kit that allows the users to inspect and debug the behavior of their photonic system. While the first hardware demonstrations are slowly taking shape, the software elements today are in an embryonic or even nonexistent state, and it will be interesting to observe their emergence and evolution in the coming years.

To conclude, we can go back to the question whether the world will need general-purpose programmable photonics? If we want to reap the same benefits of scale as with on-chip electronics, the answer is a definite Yes. The world needs photonic integration for the functionality it can provide (at a fundamental lower cost and power consumption), but to reach the same critical mass as integrated electronics, we need a much larger community that can innovate based on this technology. Photonic chips with a higher-level design interface, in the form of programmable software layers, can open up this technology to the much wider group of electronics and software engineering professionals, and even put photonic chips in the hands of the maker community.

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