Abstract Prof. Dr.-Ing. J. Christoph Scheytt

Overcoming fundamental limits of electronics by means of electronic-photonic circuits and signal processing

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Electronic signal processing exhibits fundamental limits wrt. speed (bandwidth) and noise which are caused by the physical properties of transistors. On the other hand optical signal processing allows for tremendous bandwidth well above 10 THz - a factor of 100 higher than the bandwidth of any electronic system - and is typically much more energy-efficient. Furthermore, optical signal transmission is less lossy which is the reason why high-speed fiber-optic communication networks make up the “backbone” of the internet. In addition to these advantages, optical oscillators (lasers) exhibit fundamentally better spectral properties than their electronic counterparts. On the other hand microprocessors are very cost-efficient, allow for sophisticated signal processing algorithms, use extreme small and cheap processing elements (transistors), and are programmable by means of software. Nowadays, optical and electronic circuits are still clearly separated domains. In recent years photonic-electronic integration technologies such as silicon photonics have advanced significantly. Silicon photonics technology offers for the first time the possibility to combine optical and electronic circuits on a single chip. Hence we can now combine optical devices, analog circuits, digital processors, memory, and software into an electronic-photonic integrated circuit. Combining optical and electronic signal processing in an intelligent way will allow to overcome the limits of purely electronic signal processing so that signal processors with bandwidths of several THz or clock sources with timing uncertainty in the attosecond range will be possible.