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“Energy-Modulated Computing”

Abstract:
For years people have been designing electronic and computing systems focusing on improving performance but only "keeping power and energy consumption in mind". This is a way to design energy-aware or power-efficient systems where energy is considered as a resource whose utilization must be optimized in the realm of performance constraints. Increasingly, energy and power turn from optimization criteria into constraints, sometimes as critical as, for example, reliability and timing. Furthermore, quanta of energy or specific levels of power can shape the system’s action. In other words, the system’s behaviour, i.e. the way how computation and communication is carried out, can be determined or modulated by the flow of energy into the system. This view becomes dominant when energy is harvested from the environment. This view is also analogous to what happens in biological systems. In this talk, we attempt to pave the way to a systematic approach to designing computing systems that are energy-modulated. To this end, several design examples are considered where power comes from energy harvesting sources with limited power density and unstable levels of power. Our design examples include voltage sensors based on self-timed logic and speed-independent SRAM operating in the dynamic range of Vdd 0.2-1V. Overall, this work advocates the vision of designing systems in which a certain quality of service is delivered in return for a certain amount of energy.