Subliminal: An Ultra-Low-Energy Sensor Network Processor

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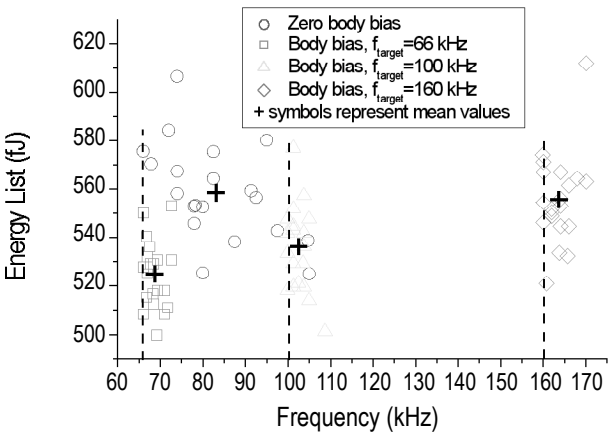

Energy and frequency distribution for 20 dies with different body biasing strategies.

Supply voltage scaling has emerged as the most effective way to achieve dramatic energy savings in a circuit. It has been shown that the energy consumed by a circuit per operation may generally be minimized by operating in the subthreshold regime (i.e., the supply voltage is below the transistor threshold voltage). We have developed a sensor network architecture, called Subliminal, optimized for operation in the subthreshold regime. The effectiveness of this architecture was first measured on a test chip in 2005. The first chip contained a series of processors (based on the Subliminal architecture) and memories. Measurements showed that one variant of the Subliminal architecture consumed only 2.7pJ/operation. Recently, we redesigned the Subliminal architecture and fabricated a new test chip. The second-generation chip remains functional at supply voltages as low as 150mV. We also find that timing fluctuations due to process and temperature variations can be virtually eliminated by applying a unique body bias to each chip. Across 20 measured chips, we observe that body biasing increases the maximum operating frequency from 66kHz to 160kHz while also reducing energy consumption of the core (without memories) from 420fJ/cycle to 399fJ/cycle. This project is supported by the Engineering Research Centers Program of the National Science Foundation under award number EEC-9986866.