

# Reversible Computing as a Path towards Unbounded Energy Efficiency: Challenges and Opportunities

Invited Talk

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## Abstract

Currently, the conventional wisdom within the microelectronics industry is that the energy efficiency (in operations per Joule) of our general low-level digital information processing technologies is beginning to approach insurmountable physical barriers to substantial further improvement. However, there is in fact one (and only one!) theoretically-possible path by which the energy-efficiency of general-purpose digital computation may continue to improve indefinitely, with no known fundamental physical limit, and that is if we reinvent computer engineering (at all levels, from device physics to systems engineering) in a way that revolves around the alternative information processing paradigm known as *reversible computing*. However, this is by no means an easy path. In this talk, we survey some of the major engineering problems that still need to be solved in order to fully realize the promise of this approach. Although these problems are extremely challenging, they nevertheless allow for possible solutions, and recent investigations hint at a range of workable approaches which we have only begun to explore. With increasing R&D effort, there is an opportunity here to lay the dominant foundation for 21st-century computer engineering, enabling a level of future economic advancement that far exceeds anything that could be achieved without developing this technology.