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Beyond Moore's technologies: operation principles of a superconductor alternative

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Review

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Abstract

The predictions of Moore's law are considered by experts to be valid until 2020 giving rise to "post-Moore's" technologies afterwards. Energy efficiency is one of the major challenges in high-performance computing that should be answered. Superconductor digital technology is a promising post-Moore's alternative for the development of supercomputers. In this paper, we consider operation principles of an energy-efficient superconductor logic and memory circuits with a short retrospective review of their evolution. We analyze their shortcomings in respect to computer circuits design. Possible ways of further research are outlined.

Introduction

Intel, one of the world's largest chipmakers, "has signaled a slowing of Moore's Law" [1]. The company has decided to increase the time between future generations of chips. "A technology roadmap for Moore's Law maintained by an industry group, including the world's largest chip makers, is being scrapped" [2]. Four years ago, Bob Colwell (former Intel chief IA-32 architect on the Pentium Pro, Pentium II, Pentium III, and Pentium IV) paraphrased the stagnation of semiconductor technology as follows [3]: "Officially Moore's Law ends in 2020 at 7 nm, but nobody cares, because 11 nm isn't any better than 14 nm, which was only marginally better than 22 nm" and "with Dennard scaling already dead since 2004, and thermal dissipation issues thoroughly constraining the integration density, the multicore era effectively ends, leading to the "dark silicon" problem, i.e., only parts of available cores can be run simultaneously".