[Invited] AI, IoT Acceralation with “via-switch” FPGA and High Level Synthesis

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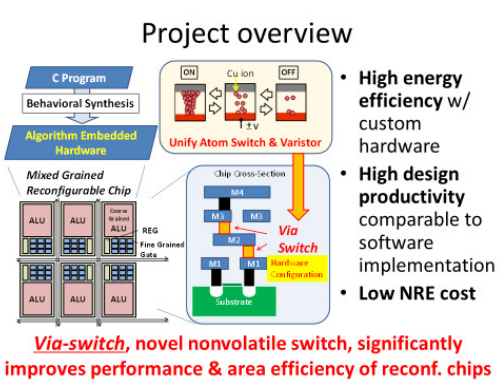
***Abstract*—This paper introduces non-volatile FPGA using RRAM based switch, called "via switch", and design environment for the FPGA, then discusses how this FPGA and proposed design environment can accelerate IoT, AI applications. The unique architecture using via-switch and a dedicated high level synthesis techniques to enable such Acceralation is explained with some examples.**

Keywords—high level synthtesis, nano-biridge, via-switch, non-volatile FPGA

I. Extended Summary

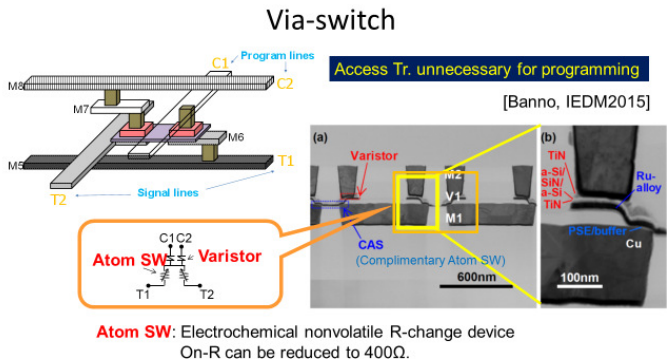
Via-switch is a nonvolatile and compact switch that consists of a CAS of “nano-bridge” and two varistors (2V-1CAS), and it is developed to implement a crossbar switch that can accommodate multiple fanouts [13]. The nano-bridge switch is nonvolatile and rewritable solidelectrolyte switch, and it is composed of a solid-electrolyte sandwiched between Cu and Ru electrodes. By applying a positive voltage to the Cu electrode, a Cu bridge is formed in the solid-electrolyte and the switch turns on. When a negative voltage is applied, the Cu atoms in the bridge are reverted to the Cu electrode and then the switch turns off. The via-switch is formed in metal-layer, so all silicon area can be used for LUT and arithmetic units, though conventional FPGA has 5% LUT and 95% switches.

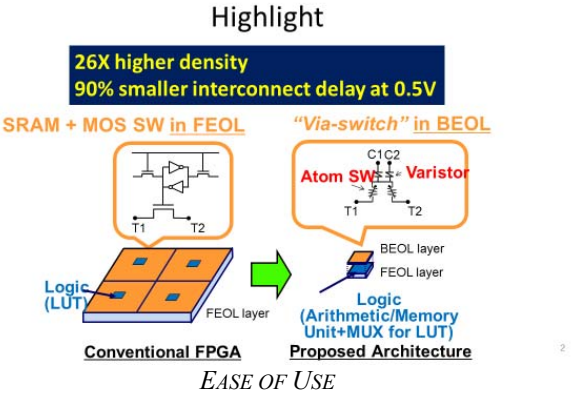


Design Environment:

We are developing complete design environment for this new FPGA, which enable users to program in C/C++ language.

This design environment consist of a high level synthesis tool, called “CyberWorkBench” and mapper, and automatic place and routing tool .We will explain the mechanism how “high level synthesis + FPGA” outperform CPU and GPU with some small example.





Ease of Use

[1] N. Banno, M.Tada, K. Okamoto, N. Iguchi, T. Sakamoto, M. Miyamura, Y. Tsuji, H. Hada, H. Ochi, H. Onodera, M. Hashimoto and T.Sugibayashi, “A Novel Two-Varistors (a-Si/SiN/a-Si) Selected Complementary Atom Switch (2V-1CAS) for Nonvolatile Crossbar Switch with Multiple Fan-Outs,” Dig. IEDM, pp. 32–35, 2015.