Time & Location: October 27, 2016 at 1:00 PM in HEC 113
Title: TOWARDS ENERGY-EFFICIENT AND RELIABLE COMPUTING: FROM HIGHLY-SCALED CMOS DEVICES TO RESISTIVE MEMORIES

The continuous increase in transistor density based on Moore’s Law has led us to highly scaled Complementary Metal-Oxide Semiconductor (CMOS) technologies. These transistor-based process technologies offer improved density as well as a reduction in nominal supply voltage. An analysis regarding different aspects of 45nm and 15nm technologies, such as power consumption and cell area to compare these two technologies is proposed on an IEEE 754 Single Precision Floating-Point Unit implementation. Based on the results, using the 15nm technology offers 4-times less energy and 3-fold smaller footprint. New challenges also arise, such as relative proportion of leakage power in standby mode that can be addressed by post-CMOS technologies.

Spin-Transfer Torque Random Access Memory (STT-MRAM) has been explored as a post-CMOS technology for embedded and data storage applications seeking non-volatility, near-zero standby energy, and high density. Towards attaining these objectives for practical implementations, various techniques to mitigate the specific reliability challenges associated with STT-MRAM elements are surveyed, classified, and assessed herein. Cost and suitability metrics assessed include the area of nanomagnetic and CMOS components per bit, access time and complexity, sense margin, and energy or power consumption costs versus resiliency benefits. In an attempt to further improve the Process Variation (PV) immunity of the Sense Amplifiers (SAs), a new SA has been introduced called Adaptive Sense Amplifier (ASA). ASA can benefit from low Bit Error Rate (BER) and low Energy Delay Product (EDP) by combining the properties of two of the commonly used SAs, Pre-Charge Sense Amplifier (PCSA) and Separated Pre-Charge Sense Amplifier (SPCSA). ASA can operate in either PCSA or SPCSA mode based on the requirements of the circuit such as energy efficiency or reliability. Then, ASA is utilized to propose a novel approach to actually leverage the PV in Non-Volatile Memory (NVM) arrays using Self-Organized Sub-bank (SOS) design. SOS engages the preferred SA alternative based on the intrinsic as-built behavior of the resistive sensing timing margin to reduce the latency and power consumption while maintaining acceptable access time.

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Approved for distribution by Ronald F. DeMara, Committee Chair, on October 3, 2016.

The public is welcome to attend.