Emerging memory technology for the Internet of Things

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Some emerging nonvolatile memories, such as spin-transfer torque magnetic RAM (STT-RAM), metal-oxide resistive random access memory (ReRAM), and phase change memory (PCRAM), have the capability of performing logic and arithmetic operations beyond data storage. This trend leads to a radical renovation of the relationship between computation and memory for IoT/IoE. To address such challenging applications, essential requirements include a large memory capacity, high memory bandwidth via in-memory data communication, fast read and write operations (low latency), low power consumption, embeddable and nonvolatile options, compactness, simple structure, low fab cost, and reliable operation even at high temperatures.

Based on these requirements for new memories, we have compared pros and cons of emerging memories as well as FDSOI one-transistor (1T) memory. In particular, 1T memory has the potential to resolve some of the challenges plaguing emerging memories. Thus, STT-RAM still needs to scale magnetic tunneling junction in 3D cross point for reliable read/write of multi-level cells; whereas ReRAM has to reduce switching current and leakage current through the unselected cell, and secure reliable operation via one of the possible switching mechanisms: fuse/anti-fuse, electron effect, metal ion motion, and oxygen ion motion. Recently, PCRAM has gained attention as the synaptic device in neural networks and deep learning. It can be successfully scaled in 3D, although power consumption remains a challenge. In this work, we suggest a new phase-change material that can lead to improved switching speed and lower power consumption for data storage and synaptic applications. We also benchmark the FDSOI-1T memory against emerging memories and find that FDSOI-1T DRAM has lower read/write latency and power consumption, but is weaker on retention and scalability.

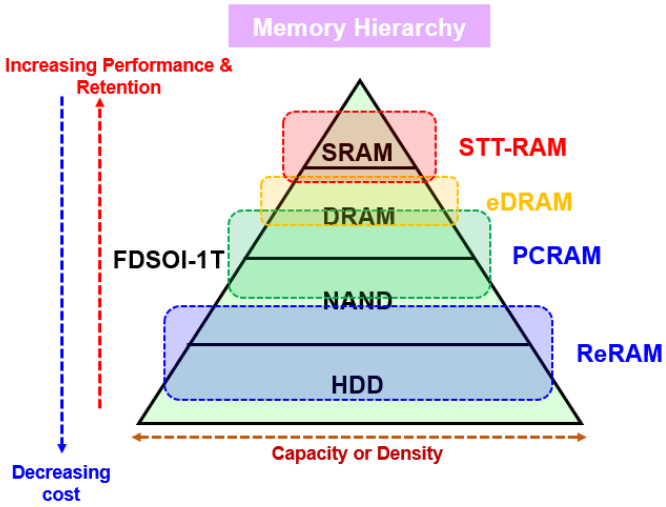

Fig. 1. Memory hierarchy including emerging and conventional memories.