CMP SCI 635: Modern Computer Architecture

Emerging Non-Volatile Memories: Opportunities and Challenges

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Paper: 15 – Secondary Storage [Xue11]

Strengths:

1. The advantage of memristor memory is that it is non-volatile, so it does not require continuous power to retain data, as DRAMs do. Also, memristors have proven to be a possible candidate for multistate memory cells, opening the way for their use in bionic brains.

2. PCM can alter the way we think about computers forever. The idea of shutting down and restarting simply becomes archaic, replaced by the concept of active use versus passive rest. Since PCM is non-volatile, imagine using a system that uses PCM based RAM. What happens when you lose power? The system will stop of course, but what happens when it regains power? It will continue on exactly where it left off.

Weaknesses:

1. While the endurance of memristors is over a billion cycles (a very good thing for a non-volatile memory element), if the circuit in question is meant to do nothing but flip state constantly then it will undeniably fail after a short time if implemented in a truly scaled-up VLSI manner and run at high frequencies.

2. Reject rate of memristors fabrication: HP can make them and make them at great capacities, but to make them at commercial volumes just wasn't working for them. The reject rate is so high that they are totally unviable, and no foundry will touch the technology. (this is, of course what I inferred upon looking up more stuff about memristors.)

Questions/Assertions:

1. In 2015, Intel and Micron announced 3D XPoint ("crosspoint"), "a new form of nonvolatile memory that the companies say is 1000 times speedier than NAND Flash and ten times denser than DRAM". Is this concept similar to memristors?

2. In *Applied Physics Letters*, researchers developed a 'flashristor,' a device that combines both the properties of a memristor and a flash-memory cell. Unlike existing devices, the memristor effect in their flashristor is not a local effect (such as a change on an atomic scale in crystalline structure), but a distributed effect in a larger area of the device, explains Aykutlu Dâna, one of the paper's authors. "*This way you can switch on and off with a high precision and repeatability*". But like its predecessors, its write and erasing times are too long (about one second).

3. A field-effect transistor could behave like a memristor if instead of varying the voltage of the gate via an external terminal, you charge it with electrons that remain trapped by changing the drain voltage only. The apparent resistance of the channel (which connects the source with the drain) would then depend on the charge in this "floating gate."

4. While looking up on internet about NVMs, I came across "*optical memory cell achieves record data-storage density*" article ["(Based on the Optalysys system) *Taking the idea of Wave Division Multiplexing and inverting it - using the separation of light frequencies to process massively parallel computational functions in a faster, more efficient manner before combining the results to be loaded in to traditional DRAM.*"], but couldn't find out much about the write latencies and wear-out statistics. Is this still a thing?

5. {About my Strength#2 point: } A CPU when it loses power is not only going to lose any data stored in the cache. It'll also lose data stored in registers and if the CPU is currently in the process of executing an instruction it'll lose its intermediary state as well. Replacing registers (and cache too) is troublesome because they're still much faster than PCM (judging by the numbers in the article) and we do not know what'll happen if a CPU tried to resume execution after being cut off right in the middle but it's probably not good (maybe a PCM ECC function to correct against such errors?).