An Introduction to Persistent Memory

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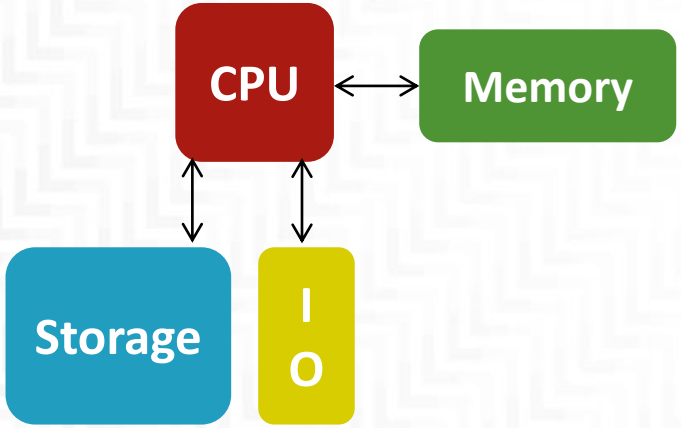
Flash Memory Summit 2016

Continuing the good life…

- For decades, computing systems have continued to significantly improve in their capability and the world has come to expect this progress.
- The temporary, run-time storing of data in the main memory has been the computer architecture paradigm for those many decades.

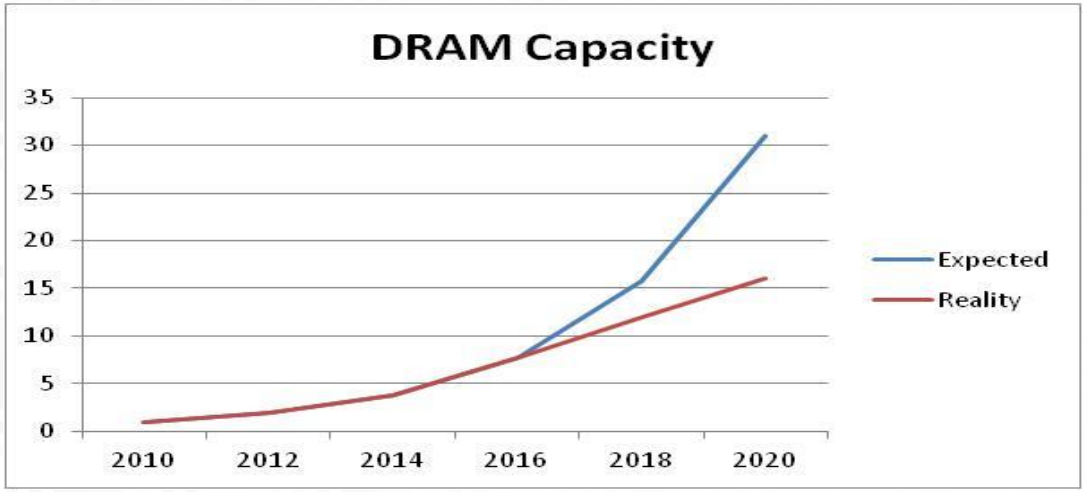
- As a key component to the system improvement, main memory has continued to advance in metrics such as performance, capacity, cost, and power.

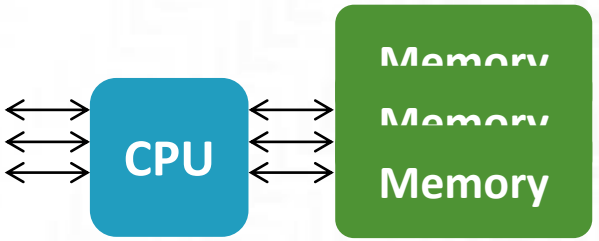


Challenges to continuing the trend

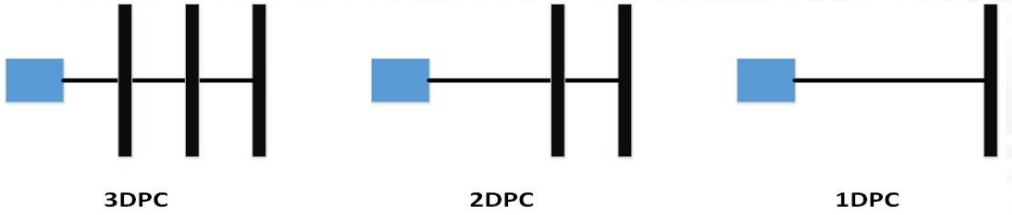
- System memory challenges have been met through improvements according to Moore's law, but they are starting to slow.

- We will not be able to continue the same increases in performance, capacity, cost, and power with the same methods in the past decades.





Memory performance and capacity challenges



Implications for datacenter systems

- Without a strong response, systems won't keep the current pace of improvement.

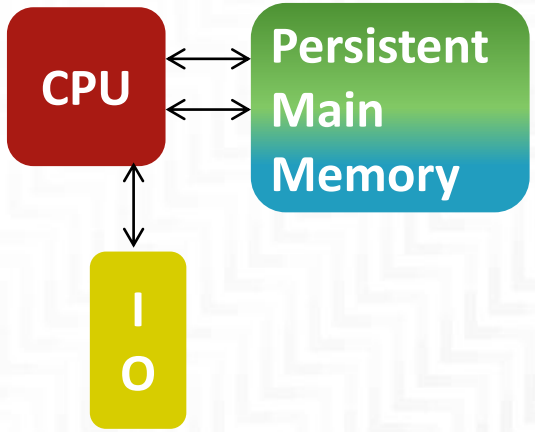
- Considering very strong data growth (Big Data) and further rising numbers of users, Cloud and Enterprise could significantly miss meeting global IT needs.

Persistent memory – one part of the solution

- Persistent memory promises to help fill the upcoming gaps in progress and drive further system improvement. To achieve this goal, the industry must take the opportunity to strongly drive its advancement.

- Persistent memory updates modern computing architecture to include main memory where stored data is preserved even when power is not applied.

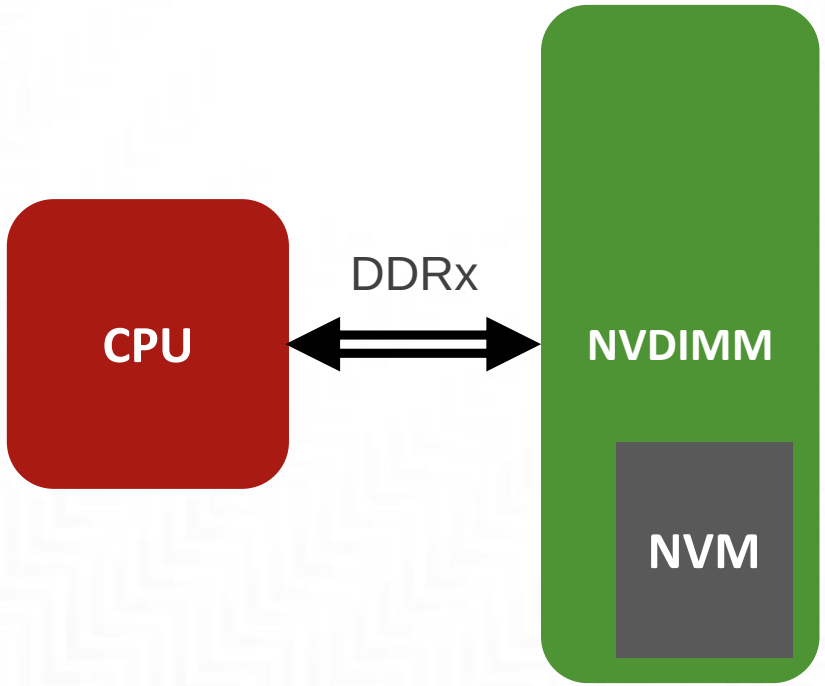
- It blurs the line between memory and storage, creating a new class of hardware and disrupting the platform paradigm of most software.



Persistent memory – one part of the solution

- Persistent memory especially comes in the form of NVDIMMs, memory modules that incorporate non-volatile memory.

- NVDIMMs are an adaptation of the main memory interface to a module with non-volatile memory components.



Persistent memory – one part of the solution

- Currently NVDIMMs do not directly connect the main memory interface to NVM, typically using logic and sometimes use DRAM together with NVM. This allows them to take advantage of the fast interface coupled with the newly added benefits of the NVM.

- There will be several different types of NVDIMM, many with different use cases. The first available are based on high volume commodity memories, DRAM and NAND Flash.

- Future NVDIMMs will include emerging NVM much faster than NAND Flash (such as 3DXPoint, ReRAM, and STT-MRAM), which will provide significant additional benefits.

Persistent memory – one part of the solution

- Often non-volatile memories offer new advantages for main memory versus only DRAM, such as higher capacity and lower cost for capacity. These can help address some of the coming capacity, cost and power challenges.

- Beyond those advantages, the **non-volatility** itself provides a **new disruptive benefit** and enables significant speed-ups in application performance along with new system capabilities.
  - Storage operations that previously required waiting on IO-attached storage now can be performed with nanosecond latency on the memory interface.
  - Application software can be re-written to unlock performance benefits such as reduced or eliminated data movement required to enable failure recovery

Challenges to progress

- There are still significant challenges to adoption of persistent memory since it requires significant work developing new hardware and software.

- Many opportunities to overcome challenges including:
  - System hardware adaptation & architecture
  - Re-writing applications to gain key NV performance benefits
  - System software ecosystem and OS support
  - Security
  - Persistent data integrity and management
  - Performance optimization

Next Steps

- Persistent memory promises to help fill the upcoming gaps in progress and drive further system improvement. To achieve this goal, the industry must take the opportunity to strongly drive its advancement.

- This work is far from complete and will require participation across all of the IT hardware and software industries to overcome challenges. There are many opportunities to participate, innovate, and create new value.

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THANK YOU