DRAM-Less SSDs

How Does DRAM Work on SSDs?

Dynamic Random-Access Memory (DRAM) on solid state drives (SSDs) generally works as a buffer or cache for certain drive operations. The drive's application-specific integrated circuit (ASIC) contains a microcontroller

for flash translation layer (FTL) functions and a separate DRAM controller to manage this memory. The FTL acts as an abstraction layer between the host system and the storage, translating between the physical and logical addresses for data, among other things. Addressing requires a 32-bit (4-byte) value in a lookup table (LUT) per 4-kibibyte of data, that is a logical page to match typical physical sector and cluster sizes. DRAM on the drive enables much faster address lookup which is particularly relevant for smaller input/output (IO) operations, especially with writes as the LUT must also be updated accordingly.

Advantage and Disadvantages of DRAM

DRAM is certainly useful for workloads requiring many small IO operations per second (IOPS) but is less useful for lighter workloads as well as those that are consistently sequential in nature. This is because you only need so much memory for mapping, dependent on the workload, and some or all can fit into the controller's even-faster static random-access memory (SRAM). The presence of DRAM in a drive increases cost and in some cases power consumption while potentially putting out more heat. For client drives, which tend to be focused on reliability and relatively lightweight workloads, DRAM-less options can therefore offer a lower total cost of ownership (TCO).

DRAM on PCIe® (NVMe™) vs. SATA (AHCI) SSDs

Peripheral Component Interconnect express (PCIe®) and serial ATA (SATA) drives have very different performance limitations and, further, can also handle mapping differently. Specifically, PCIe® SSDs with the non-volatile media express (NVMe™) protocol can utilize what is known as a host memory buffer (HMB). This allows a DRAM-less PCIe® drive to leverage some system memory for its mapping. While SATA SSDs, generally using the advanced host controller interface (AHCI) protocol, cannot use HMB, they are also limited significantly in performance by the interface, especially with regard to IOPS. When it comes to client SSDs, it's likely that any SATA SSD is sufficient but the move to PCIe® can be kept cheaper without DRAM by utilizing HMB instead.

Summary

DRAM can be very useful on SSDs for improving FTL performance, reducing latency and increasing IOPS for certain workloads. However, this does not apply to sequential and lighter workloads, potentially adding unnecessary cost. Client SSDs in particular aim to be simple and reliable for everyday usage and therefore can be more streamlined. PCIe®-based SSDs can instead rely on HMB to get any potential benefit, using only a small amount of system resources. SATA SSDs tend to be limited by interface and protocol but are often sufficient for daily workloads. In either case, client SSDs are a good place to save a bit of money by avoiding unnecessary hardware.

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- Low latency
- LDPC technology

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