

Using an Intel[®] NVMe*-based SSD Boot Drive as a Caching Device with Intel[®] CAS

Technology Brief



Revision History

Revision	Description	Date
001	Initial release of this document	January 2017

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Introduction

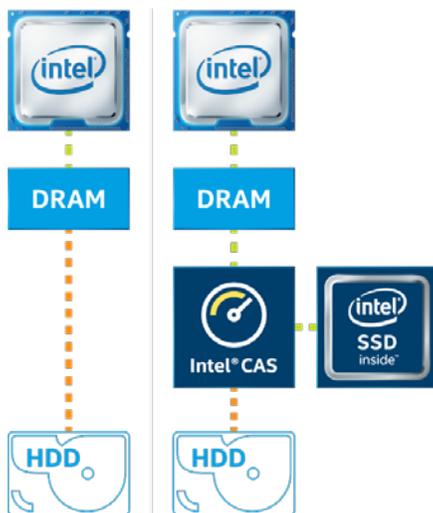
With the introduction of Intel® 3D NAND technology, Solid State Drives (SSDs) capacity is increasing while the price per gigabyte (GB) is declining. Although this means lower cost, high capacity SSDs, it places cost and availability pressure on lower capacity, entry-level SSDs. As the size of the base NAND media increases, so do the challenges of designing small capacity SSDs. Additionally, the cost per GB of lower capacity SSDs is increasing relative to larger capacity SSDs within the same series because the non-media component costs become a larger percentage of the overall SSD cost. It is these factors that are making it more difficult to produce and procure lower capacity SSDs.

However, there are still certain usage models that do not require higher capacity SSDs. One example is boot drives in server appliances where using a high capacity SSD leaves much of the capacity unused since the space required for the installed operating system and applications is not growing as fast as SSD capacity.

A good use for this unused capacity is to assign unused space as a caching partition. Intel® Cache Acceleration Software (Intel® CAS) enables the creation of caching partitions in an easy and user-friendly way. The user installs the software and an Intel® SSD to get the most from the database, virtualization, hosting, cloud, or big data servers.

Intel CAS runs in the OS so the user does not need to make any changes to the storage or application backend, and while the software works with any SSD, it is validated and optimized to work best with Intel® SSDs. To take full benefit of Intel CAS, using Intel NVMe® SSDs as caching drives is recommended.

This following figure shows the high-level architecture of CAS-enabled solution, where the Intel® SSD with Intel CAS serves as a caching media between storage and DRAM.



How Intel® Cache Acceleration Software Works

Intel CAS identifies and stores critical application data on the higher performance SSD media. When the application frequently accessing that data, it can access it faster. Intel CAS constantly analyzes the data needs to ensure that everything is where it should be. The user can also identify which data to prioritize and selectively optimize and accelerate the performance of those applications. Intel CAS supports Linux* and Microsoft* Windows* Server operating systems.

For information, see the Setup Guide: *Setting a Caching Partition on a Boot SSD with Intel® CAS*.



Recommended Drives

The following Intel® Solid State Drives for the Data Center are part of the Intel® 3D NAND SSD family of products and are recommended for hybrid use as boot and caching devices:

SATA Drives

The Intel® SSD DC S3520 Series delivers the combination of data integrity, performance consistency, and drive reliability. With a competitive IOPs/\$, the Intel SSD DC S3520 Series is the ideal replacement for Hard Disk Drives (HDDs).

Recommended boot drive capacities: 150GB, 240GB.

NVMe Drives

The Intel® SSD DC P3100 Series delivers ideal endurance and performance for read-intensive workloads in the data center. With the space-saving advantages delivered by the M.2 form factor and its power efficiency, data centers can expect to see total cost of ownership benefits with the DC P3100. Validated for the most common data center environments, including boot, search indexing, edge caching and web hosting, the DC P3100 meets value-based needs.

Recommended boot drive capacities: 128GB, 256GB.

Performance Results

To show the performance benefits of using part of a boot drive as a cache with Intel CAS, three configurations were tested.

- **Configuration 1:** Intel SSD DC S3520 Series 2.5" 150GB as a boot drive, 50GB boot partition, remaining space unallocated, caching disabled.
- **Configuration 2:** Intel SSD DC S3520 Series 2.5" 150GB as a boot drive, 50GB boot partition, remaining space allocated for cache, write-back caching enabled.
- **Configuration 3:** Intel SSD DC P3100 Series M.2 256GB as a boot drive, 50GB boot partition, remaining space allocated for cache, write-back caching enabled.

System Setup:

- Hardware: Gigabyte* GA-Z170X-UD5, Intel® Core™ i7-6700 3.4GHz 65W 4 cores, 24GB memory, HDD Western Digital* 4TB Enterprise-class HDD SATA 6GB/s 64MB Cache WDC* WD4000FYYZ-01UL1B3
- Operating system: Windows* Server 2012 R2
- Intel® Cache Acceleration Software v. 3.1.0.83 Write-Back (WB) mode
- Virtual Machine configuration: System Configuration: 1.5GB memory, 40GB storage, Microsoft Windows 7 Ultimate 64-Bit



Tests:

Two different tests were performed against each configuration:

- **Synthetic test with IOMeter* tool for random write performance and random read performance.** Test settings: 8 workers, queue depth 16 for each worker, 8GB or 40GB drive span, 4K block size - aligned, 100% random, 100% read or 100% write.

Results for IOMeter test:

Configuration	4K random read, 40GB drive span, IOPS	4K random write, 40GB drive span, IOPS	4K random write, 8GB drive span, IOPS
Configuration 1	370	404	402
Configuration 2	45834	29044	33600
Configuration 3	52769	26360	39272

- **Hyper-V* Boot Storm – booting multiple Hyper-V virtual machines at once.** Time measured from pressing power-on button until guest OS shows desktop. For test with enabled caching, virtual hard drive files were included and pinned to cache by way of the Intel CAS interface.

Results for VM boot storm test:

Configuration	Boot Time (seconds)
Configuration 1	154
Configuration 2	26
Configuration 3	19

Summary

As the test results show, enabling caching with Intel CAS on an Intel SSD DC S3520 Series boot SATA SSD provides ~124x performance increase in synthetic random read test with IOMeter, up to ~83x increase in random write test with IOMeter, and ~6x lower VM boot time for VM boot storm usage model. With an Intel SSD DC P3100 Series boot NVMe SSD, the performance gain is even higher at ~142x in random read test, up to ~98x for random write test, and ~8x VM boot time reduction for the VM boot storm usage model, as compared to the enterprise SATA HDD. While the Intel DC SSD S3520 Series 150GB and Intel DC SSD P3100 Series 256GB are at about the same price range, the Intel SSD DC P3100 with NVMe provides 106GB more space for caching partition, ~15% higher random read performance, with comparable random write performance (up to ~17% performance gain on smaller drive spans) and ~27% faster VM boot.

Additional considerations for choosing the right boot SSD with a caching partition also include endurance and capacity requirements, which are highly dependent on usage model and workload.