Intel® Data Center Solid-State Drives (SSDs)

The Data Center Solutions team, within the Intel® Non-volatile Memory Solutions Group (NSG), has received a number of questions from end users about the differences between Intel® SSD Data Center Family and Intel® SSD Consumer Family. End users often express a desire to use the less expensive client/consumer SSD, specifically the Intel® SSD 530 Series client drive, in place of the Intel® SSD Data Center (DC) S3500 Series in their data center environments. This Technology Brief explains the reasoning behind using a Data Center SSD in a data center environment; the product specifications listed below and current web pricing[1] for the 80GB versions of both data center and consumer classes of SSDs are used as a reference throughout. The smallest common size of SSD is discussed to highlight the differences between the two classes. When comparing the smallest capacity of the two SSDs the GB/Day in write endurance is similar, normally this fact is what spawns this discussion.

All calculations in this article are based upon the data in these two product specifications as derived by Intel based on internal Intel testing.

Intel SSD DC S3500 Series Product Specification:
http://www.intel.com/content/www/us/en/solid-state-drives/ssd-dc-s3500-spec.html

Intel SSD 530 Series Product Specification:
http://www.intel.com/content/dam/www/public/us/en/documents/product-specifications/ssd-530-sata-specification.pdf

For those unfamiliar with SSD technology, write endurance indicates how long the device is expected to last, typically specified in GB/Day or Terabytes written (TBW). Below are the endurance ratings from the product specifications and current web pricing.
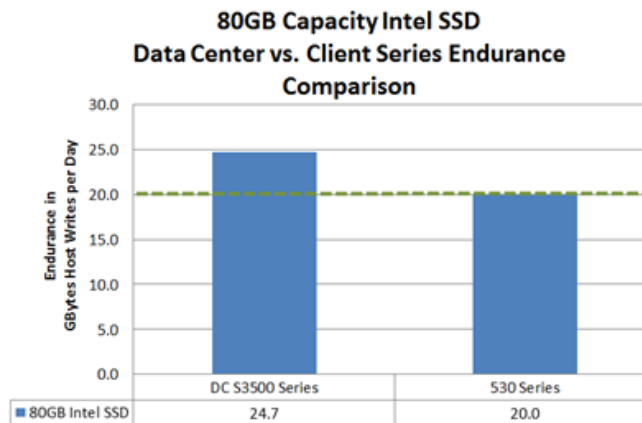
Endurance rating 80GB Intel SSD DC S3500 Series: 24.6 GB of host writes per day, based on web pricing $102.00 (March 2015)

Endurance rating 80GB Intel SSD 530 Series: 20 GB of host writes per day, based on web pricing $80.75 (March 2015)

Upon closer review of the product specifications, you can see that the host writes per day increases (expressed in TBW) with the capacity of the Intel SSD Data Center S3500 Series, whereas the Intel SSD 530 Series (client/consumer drive) endurance is fixed at 20 GB/day. The write capacity of the consumer drive does not scale as the capacity of the drive increases, but the write capacity of data center drive does.

Endurance

As presented in the product specifications, both SSDs are expected to last 5 years. For the Intel SSD 530 Series 80GB, this assumes 20 GB host writes per day. The same capacity Intel SSD DC S3500 Series provides 24.6 GB host writes per day. This is calculated by doing some quick base-ten math on the Intel SSD DC S3500 Series: 45 TBW x 1000 yields Gigabytes, divide by 365 for days per year, and divide again by 5 for the estimated 5 year life of the drive. The result is approximately 24.6 GB host writes per day for the Intel SSD DC S3500 Series 80GB capacity. The chart below compares the average internet pricing of both data center and client/consumer class SSDs in the 80GB capacity; Intel SSD DC S3500 Series is $102.00, and the Intel SSD 530 Series is $80.75.

**80GB Capacity Intel SSD
Data Center vs. Client Series Endurance
Comparison**

	DC S3500 Series	530 Series
80GB Intel SSD	24.7	20.0

Note: Calculations based on Intel® SSD DC S3500 Series and Intel® SSD 530 Series Product Specifications.

At first glance, it appears that using the Intel® SSD DC S3500 Series instead of the Intel® SSD 530 Series costs 36% more for an additional 5 GB per day in write activity. This raises the "Why pay more?" question, but deeper investigation is important when considering data center SSDs. This investigation should include consideration of the workload, the need for end-to-end data protection, power-loss circuitry, and performance consistency.

[1]Average sale price comparison from www.CamelCamelCamel.com, March 2015

Workloads

When endurance tests are conducted on the Intel® SSDs, client SSDs are tested with a *client* workload and data center SSDs are tested with a *data center* workload. These workloads differ in the way they perform IO to the drives, their level of complexity and the demands on the drive. For example, the data center workload often demands the ability to operate 24 hours a day, 7 days a week, making it much more strenuous on the drive than the typical client workload. Put this in context by thinking of the SSDs as two types of marathon runners. Think of the client SSD as the marathon runner faced with a relatively flat course with a few small hills. In comparison, the data center SSD marathoner's course runs through mountains and canyons. To compare the two by using finish times does not take into consideration the intensity of the terrain and the requirements on them. The same is true of SSDs specifically designed for the client or for the data center; they perform under very different conditions. The SSD selected for a data center workload must be capable of enduring the more strenuous demands.

End-to-End Data Protection

In enterprise, the need to have accurate, highly reliable data is another reason to select a data center SSD. To support this requirement, Intel Data Center SSDs provide End-to-End Data Protection (E2E). With E2E, data is internally checked, validated, and corrected as necessary. This occurs at every step; from the point data enters the drive as a write, and continues until it exits the drive as a read. Client drives don't require the same level of error correction capabilities due to lower application complexity. In contrast, Intel Data Center SSDs are specifically designed to meet the high data reliability requirements. Returning to the running metaphor, consider a marathon runner who can take in information, perform error-correction and use that data to adjust how they are running.

Power Loss Imminent

Another reliability feature designed into Intel Data Center SSDs is Power Loss Imminent, or PLI. The PLI feature monitors the power being supplied to the SSD and if it senses a loss of power it automatically stops both external and internal IO and makes sure that all in-flight data is written to the storage media (NAND). In the event of a power outage, the PLI feature uses energy stored within the SSD in special super-capacitors (like a short-term backup battery) to write to the drive any data for which the operating system (OS) received an acknowledgement. This function is especially important in data center workloads. Using the marathon runner illustration again, imagine if as you were approaching the finish line, you ran out of energy and had the ability to tap into a reserve to finish the race.

Performance Consistency

Last but not least, client and data center SSDs are built for different expected duty cycles. The data center SSD is designed to run 100% of the time; housekeeping activities occur as the drive operates, and generally do not alter the observed performance of the SSD. With this workload in mind, the Intel® SSD DC S3500 Series includes a "Quality of Service" metric in the specification sheet which outlines the maximum observed latency up to 99.9999% of the time. In other words, the data center marathon runner achieves the same marathon time, every time, irrespective of the running conditions. In addition, because of this consistent performance the Intel® SSD Data Center Family scales well in RAID configurations whereas consumer drives do not.

While evaluating consumer SSDs and data center SSDs, it's logical to look at price and ask, "Why should I pay more for a data center SSD?" However, when you consider the needs of the data center; the ability to run 24/7, manage complex applications, and deliver accurate data reliably, data center SSDs provide significant performance benefits over consumer SSDs. In a nutshell, that's the "why" behind data center class SSDs. Given all of these reasons, the question becomes, "Which runner do you want on your data center team?"