



ENTERPRISE STORAGE STACK

ESS Can Reduce the Cost of Using Intel DC S3700 SSDs

The Intel DC S3700 series of SSD is a well respected Enterprise SSD. The S3700 is built with eMLC memory with more than 20,000 erase cycle endurance Flash, many times the endurance of Flash commonly used in Commercial grade SSDs.

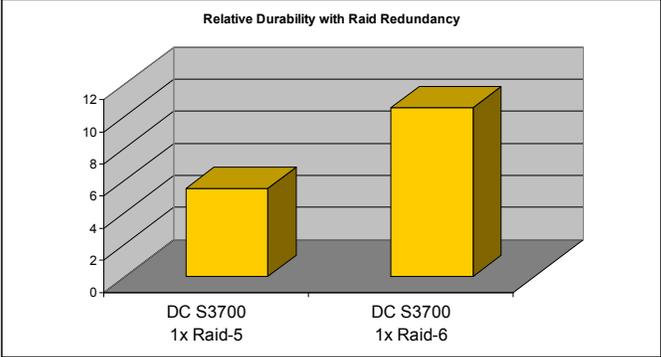
Intel advertises that the S3700 will accept 11 overwrites per day for five years whether used in linear write mode or in random write mode. Intel does not publish wear amplification, but this is irrelevant in the context of the warranty.

Intel S3700 drives are reasonably priced based upon their extra endurance. The cost is around \$2.50 a gigabyte. For instance, Newegg sells 800GB drives for \$1,980.

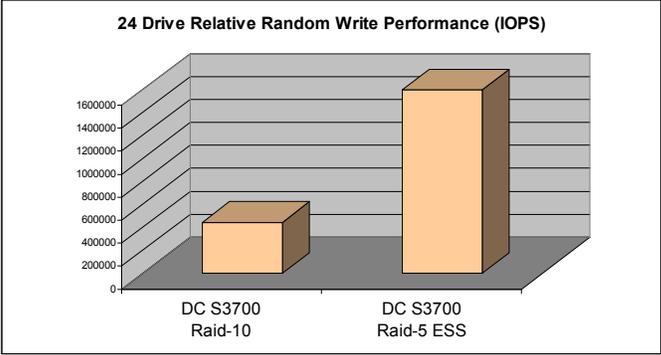
Enterprise Storage Stack is a block filter which converts randomly written IO into atomic FIFO linear writes bounded on both erase block and Raid-stripe boundaries.

As a result, intrinsic wear amplification is typically <1.3:1. Similarly, ESS is extremely fast. Writes occur at the linear write speed of the device, which is about five times the random write speed of the device.

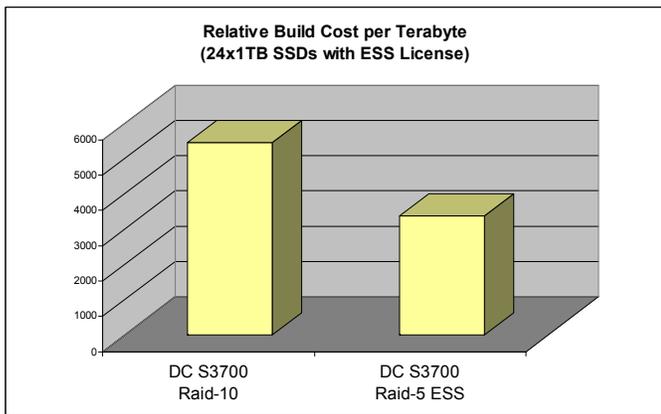
When used with a Raid-set, the advantages of ESS increase. Because ESS writes only linearly, it avoids the 2x raid amplification inherent in both Raid-5 and Raid-10, reducing Raid-5 raid amplification to $1/(n-1)$. In large 24 drive arrays, ESS can almost halve wear, and more than halve it for high security Raid-6 sets.



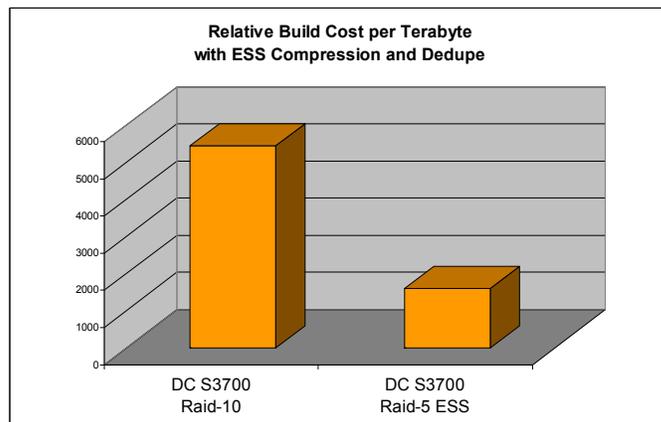
Similarly, ESS, when used with a Raid-5 set will perform much faster. 24 S3700 SSDs, managed by Linux Raid-5 will only write about 40,000 IOPS – which is normally an unacceptable performance for Flash appliances. The same media, Raid-10, will deliver 444,000 write IOPS. But with ESS managed Raid-5, an S3700 set will deliver far in excess of a million write IOPS.



But what is most compelling, as the following table shows, is that while ESS delivers more durability in terms of total writes per day as well as radically greater random write speed, ESS delivers these capabilities in our basic topology at significantly lower total cost ... reducing manufacturing costs per usable terabyte by a good 40%.



collectively double addressable space. In such an environment, ESS based systems utilizing S3700 SSDs become 80% less expensive than the same hardware used in a generic manner.



The possible cost savings and benefits do not end with our basic engine.

Our Enhanced Engine adds a number of both useful and cost-saving capabilities.

On the durability side, these include checksums and micro stripes. Checksums assure that all read and written data is correct, while micro stripes permit the intelligent repair of damaged data. These durability elements enhance durability elements already present in the basic product, such as the soundness of never overwriting existing data, and of writing FIFO to assure data continuity.

ESS's deduplication and compression engine is designed to create space efficiencies real time. The entire advanced engine, including appropriate compression and deduplication, normally writes at levels above a million IOPS.

Similarly, the advanced engine uses a virtual memory approach to reduce the amount of RAM required, and conversely to permit the construction of very large systems. With enhanced ESS, it is possible to build systems addressing a hundred terabytes of physical Flash, with logical addressing approaching a petabyte.

Compression commonly increases physically addressable space by a factor of two. In ordinary usage, Deduplication will improve space utilization by a further 15% to 20%. In VDI and similar environments, deduplication can reduce physical storage requirements by a factor of 5x to 10X.

While enhanced ESS cuts manufacturing costs per terabyte even further, it also improves media life by reducing the amount of data written to the media either through compression or the virtualization of deduplication. Accordingly, a 2x increase in logical space utilization decreases total wear by a factor of two, while increasing the number of supportable daily overwrites by a factor of two.

The following table shows the relative cost per terabyte of Enhanced ESS, assuming that compression and deduplication will

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