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SSD – Solid State Drives (RunCore)

It may be well known by everyone that retailers were raising their prices on Hard Drives because flooding in Thailand had shutdown a number of key production facilities. As forecasted, it could take up to a year more for the industry to return to pre-flood production levels, till then there is a remarkable shortage and price increase on the traditional mechanical hard drive market. This forced a lot of experts all around the World to think whether to buy 120 GB super fast storage SSD or 1 TB of traditional slower storage hard drive for the same price, which was never so closed to each other. In this article we try to summarize the key factors, which characterize the SSD drive technology and briefly compare it to the traditional hard drive technology.

Solid-state Drive

A solid-state drive (SSD) is a device based on electronical storage methods containing semiconductor non-volatile flash-memory chips instead of magnetic disks combined with electromechanical reading and writing mechanism. Due to the internal structure, the missing mechanical parts such as electric motors, the noise, the consumption and the weight is minimized.
These devices are much more shock resistant, reliable, silent, have lower access times and latency, but usually more expensive. The same interface that traditional hard disks have (ATA / SATA) provides interchangeability in most applications. For internal drives today the SATA is the most common interface with speed upto 250-300 MB/s.

The above general advantages of SSD are well known for most of the professional and also hobby users. In order to be able to decide for a storage device to be used in a certain application it is recommended to take a deeper look at the details of the technology.

Lifetime

The most common fear concerning using SSDs is about the lifetime issue.

The flash based memory cells are capable to handle a limited number of read/write cycles, however it does not mean that the SSD goes wrong from one moment to the other. The SSD controller takes care that those cells, which are getting closer to their end of life would be marked out of use and their data content will be moved to other cells. There are many different algorithms in use to provide equal cell load, therefore the lifetime could be extended to the desired level.

Reliability

Especially for drives of portable devices the reliability is a question of mechanical concerns, traditional hard drives platters are very fragile, and the complete mechanism as well as the magnetic surfaces are very sensitive for mechanical impacts such as shock and vibration or presence of foreign objects like dust.
SSDs, due to their electronic operation principle, are much less affected by these factors.

Power consumption and heating

Heat generation and heat tolerance are key factors when selecting SSD drives instead of traditional hard drives, especially when the drives are supposed to be used in RAID organization, or in portable PCs, which have itself a significant heat dissipation.
Due to no power draw for the motors, energy consumption is low, but with regards to the consumption/capacity ratio, it could be weaker than traditional disks: unlike the small consumption change of a hard disk drive when capacity increases, the SSD's consumption increases almost linearly as the memory capacity grows..

Data access speed / performance (IOPS)

Since the drive does not have to spin up the platters or move and position heads, data can be read from the storage nearly instantly.Since the access times are low, there is no relationship between the spatial localty and retrieval speed of data, fragmentation of the stored data has no significant affects on the performance when reading.
There are many different factors having affect to the overall performance of the SSD drives (when also writing data to). SSD data storage is divided into blocks composed of multiple pages, which block should be completely earsed prior to re-writing.

The write speed will strongly depend on the unneccessary block erase operations due to partition misalignment.
The used Flash memory technology requires a lot of support from the SSD controller in order to provide reliability on top of the high performance

operation. In traditional file systems, when data should be deleted from the disk, it is not physically destroyed, just marked as overwritable.

With SSDs the TRIM support handles deletes and writes by destroying the data instead of performing an entire block erase in order to avoid performance degradation and helps to reduce wear by decreasing the number of merge operations on an SSD drive.

One of the key factors having affect to the speed is the type of workload. The sequential large block load results much better performance than the small block operation, especially the random load of this type.

The random data distribution within the flash impacts efficiency through the free space recovery method for subsequent writes (TRIM).
Just like fragmentation of traditional hard disks, the historical workload that the drive has been subjected to (transaction history), has huge impact on performance.

Free space maintenance and recovery are the main tasks for background operations for SSD drivers, which are affected by the available unallocated space on the drive. When drive is Fresh Out Of Box (FOB) a little background action is required, so the performance is high.
As the drive is getting used, remaining free space becomes more constrained, there is an increasing need of background operations, the performance is impacted. That is the reason a new or recently formatted SSD performs temporary better.

Over-provisioning helps to keep always enough unallocated flash blocks by reserving a certain percentage of the total capacity, but it has negative affect on the price / capacity ratio.

Write amplification – the ratio between the real amount of data written to flash and amount of data to be written by the application – is also affected by the over provisioning, since the more background space is available, the more efficient flash management algorithms will be able to operate.

Minimizing the WA is also a key factor to reach higher lifetime for the SSD. Background operations such as garbage collection (creating free unallocated flash blocks) in idle periods, can also support overall performance, even if this could temporary increase write amplification. The best performance is with drive that utilized by both trim and idle time garbage collection.

Drives with lower over-provisioning lower the costs per GB, but performance

Hard disk versus SSD drives		
Property	**HDD**	**SDD**
Sensitivity to magnetic field	Can alter or destroy data	No affect
Power consumption	Cca 7W	Cca 2W
Spin up time	Upto 2 sec	Instant
Read speed (SATA)	100 MB/s	250 MB/s
Write speed (SATA)	50-70 MB/s upto 118MB/s	200-250 MB/s
Lifespan	No finite number of writes, cca 1.500.000 Hrs, but may fail of mechanical impacts	Write cycle limits, however 350.000 Hrs with constant writes is common (40 Years)
Erase	No need to erase, data could be overwritten	Need secure erase feature prior to write data over
Cost	Today high but normally lower money / GB	Higher money / GB
Noise	Noticeable (especially when seeking, spin up)	No noise
Heat	Small heat but 3x higher than SSD	1/3 of the heat of HDD
Shock sensitivity	Poor	Resistant to mechanical shocks (vibrations)
Fragmentation	IOPS is affected strongly	No need of defragmentation

and endurance is negatively affected, especially in write intensive workloads.

Comparison of SSD versus Traditional Hard drives

Taking all above factors in mind one can decide if the application is able to afford an SSD to be used. To help in the choice the below table summarizes the differences of properties of SSDs and traditional hard disk drives.

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