



The Economics of Intelligent Hybrid Storage

An Enmotus White Paper
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SUMMARY

Solid State Storage is no longer the storage of the future. It can be found in high-end data centers, in the servers of small to medium enterprises and in ubiquitous consumer products around the globe. Without a question it provides better performance than traditional hard drives as well as power and cooling benefits. Its advantages undeniably make SSD storage a must have component of any enterprise storage solution. While one can argue that the price points of Solid State Storage are declining at a rate that will make all flash enterprise storage solutions nearly as affordable as hard drives, and therefore will soon replace hard drives, the reality is that this point is still a long way into the future. Pure flash solutions remain the domain of a small minority.

Top of the line all flash solutions fill an important high performance niche in the market, as there are applications that demand the performance and the cost is justified by the benefits of these solutions. For the majority of the market, this is not the case. Historically, to get top of the line performance required powerful external storage solutions with banks of high capacity, 15K rpm drives. In many cases, the drives were short stroked to improve performance at the expense of the drive capacity. With the advent of solid state storage, the emerging solution that meets, and in most cases exceeds the requirements of the majority of the market, is Hybrid Storage, which combines the performance of solid state storage with the capacity and economic advantages of hard disk drives. The new generation hybrid storage solutions deliver both on performance and economics.

THE STORAGE PRICEGAP

The price gap, as well as the performance gap, between an all hard disk drive (HDD) solution and an all solid-state solution is significant. Even if price was not an issue – and it is – a pure flash solution would be performance overkill for most applications. When choosing a storage solution, IT organizations must consider their individual workload requirements along with their budget restrictions. For example, does my application require high IOPS or high throughput? Is my workload write intensive or read intensive? What percentage of my data is considered “hot”? These questions, along with many others, help determine what storage media is necessary. The appropriate storage media has a very significant impact on solution costs. For example, the price delta between high capacity 7200 RPM drives and high performance 15K drives is substantial, but the \$/GB number price difference grows by the order of a magnitude when comparing HDDs to solid state storage. Even the price difference between read intensive and write intensive solid stated drives can be as much as 4X. When upgrading from an all HDD solution, users are left with the difficult challenge of crossing both a large performance and price gap, with few options in between.

For those who want it all - The performance advantages of solid state but the price points and capacity advantages of hard drives, the answer is Enmotus' FuzeDrive™ hybrid storage software with automated real-time MicroTiering™ technology!

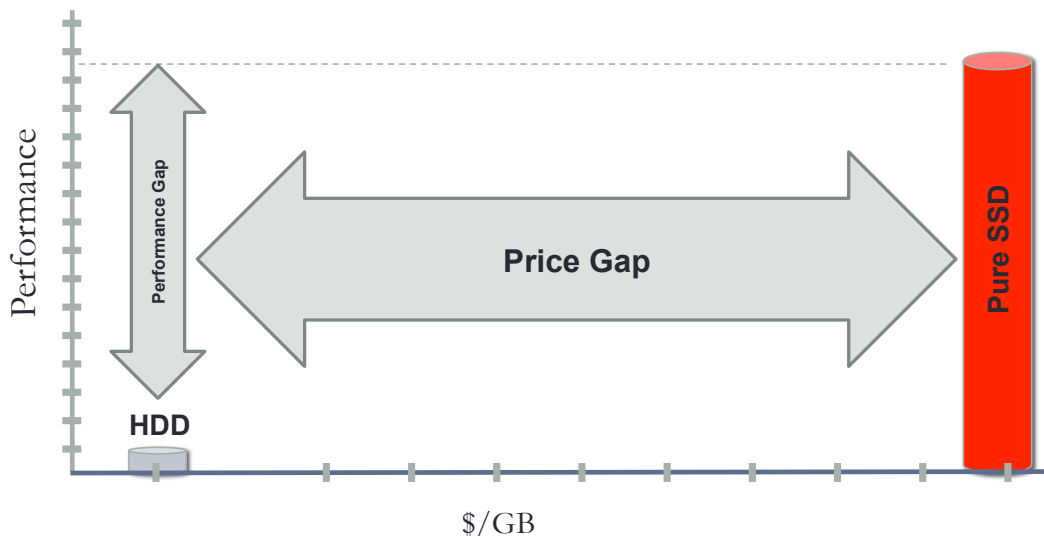


Figure 1 The Performance and Price gap between traditional hard drive storage systems and all flash storage makes it difficult to justify a shift to all flash storage

CLOSING THE GAP

Using SSDs as a caching device narrows the performance gap for a nominal increase in cost, but it does not close the gap. While caching certainly provides a performance boost to hard drives, inherent limitations prevent caching from scaling. First, adding additional solid state storage as a cache hits a point of diminishing performance returns. As you add cache beyond a certain point, the system will demonstrate very little, if any, performance gains. Additionally, write back mode must be enabled in order to accelerate host writes, which creates significantly more activity to both the SSD and the hard drive, as the cache must constantly flush the data to disk. This also requires that the cache be partitioned for reads and writes, which effectively halves the size of the total cache to be used for either operation. The bottom line is that while caching significantly reduces the dollars per gigabyte gap between hard drives and SSDs, while providing increased performance, it falls short of achieving and will never reach the performance of an all SSD solution. Furthermore, caching has not shown to be effective in streaming applications. Finally, using your solid state storage as a cache requires that you use your most expensive permanent storage media as a high speed temporary storage repository. Isn't DRAM much better suited for this application?

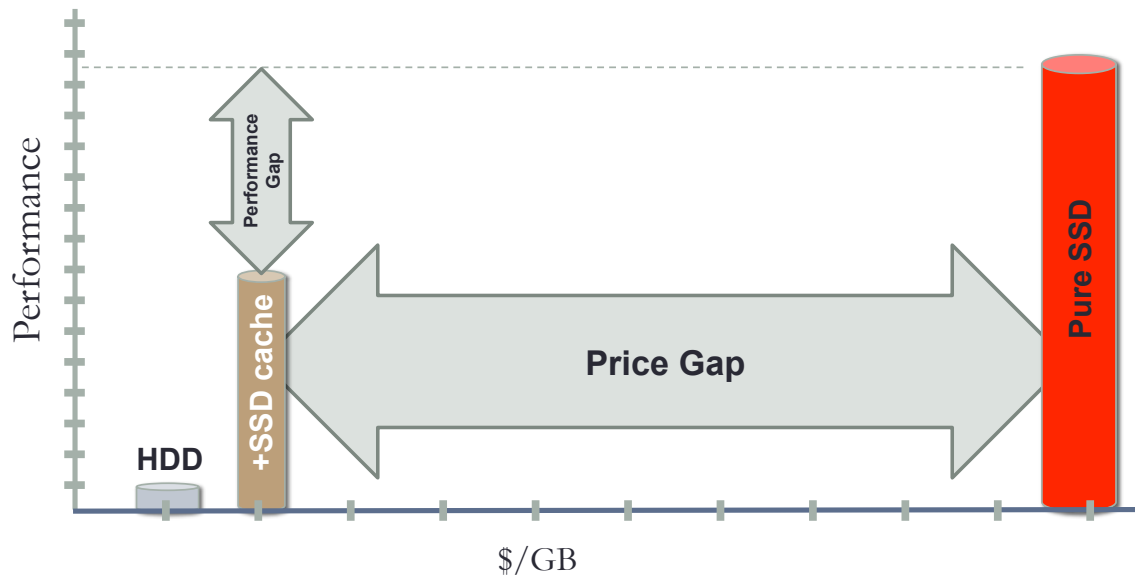


Figure 2 Adding flash is a simple and cost effective way of increasing performance.

HYBRID STORAGE PROVIDES FLEXIBLE SCALABILITY

FuzeDrive is Enmotus' intelligent hybrid storage software that enables server based hybrid solutions using off the shelf hardware by “Fuzing” SSDs and hard drives into fully automated virtual hybrid storage. A “Fuzed” drive appears to the operating system as a single “virtual” volume, and is comprised of both a fast tier (tier 0) and a slower tier, which is typically a higher capacity storage media. Each of the tiers can have independent RAID configurations.

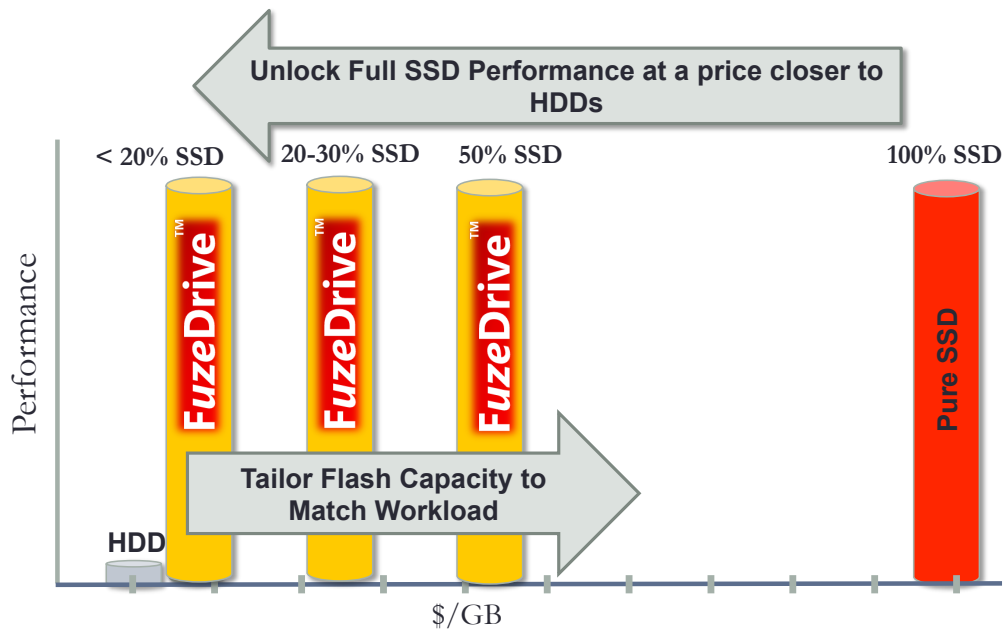


Figure 3 Hybrid storage allows reads and writes to be serviced out of the fast tier enabling full flash performance. The size of the flash tier can be scaled to match the size of the working set and to satisfy the most demanding workloads

The FuzeDrive's software automated real-time tiering technology enables True SSD performance at an affordable price. Tiering provides similar benefits to caching, but a major differentiator is that the flash tier is completely visible to the user and operating system. The SSD is treated as primary permanent storage (not a temporary cache) therefore the capacity of the SSD tier is additive to the capacity of the hard disk drives(s), resulting in better utilization of the storage resources. The hybrid volume provides both high performance and high capacity, unlocking the performance capabilities of a pure SSD system at a dollars per gigabyte price point closer to hard drives. In some cases, in server solutions, the \$/GB of the tiered hybrid solution can be lower than a pure hard drive solution, as lower cost high capacity drives can be substituted for multiple high priced short stroked 15K RPM drives. The tiered solution also closes the performance gap with pure SSD solutions.

INTELLIGENT AUTOMATION MINIMIZES COMPLEXITY

MicroTiering is Enmotus' proprietary technology that controls the automated movement of virtual and physical data pages. Enmotus MicroTiering technology promotes active data to the SSD tier in real time and leaves it there permanently, unless it is replaced by more active data at a later point in time. Host accesses are allowed to proceed directly the flash tier, therefore reads and writes for all hot data go straight to the SSD, and the user experiences true SSD performance. The hard drives will simply be a repository for the less frequently accessed data. A statistics engine monitors the access patterns to the volume and determines in real time when data needs to be promoted or demoted to or from the fast tier. Operating at the block level means that only active portions of files need to be moved, which increases the tiering efficiency, thereby providing better utilization of your flash resources as well as real time reaction to dynamic conditions. Tunable parameters provide IT administrators the ability to tune policies according to individual workloads. Once configured, the FuzeDrive software is fully automated and requires no intervention.

Enmotus's eLiveMonitor graphically displays the disk IO activity and the relative mapping of the flash versus the hard drive portions of the tiered virtual disk. This provides users an easy to use tool that displays the effectiveness of the system and allows visual confirmation of the real time tiering.

An advanced pinning function allows IT administrators to promote or demote files on demand and lock the files to either the fast or slow tier if desired. A scheduling feature allows files to be promoted in advance.

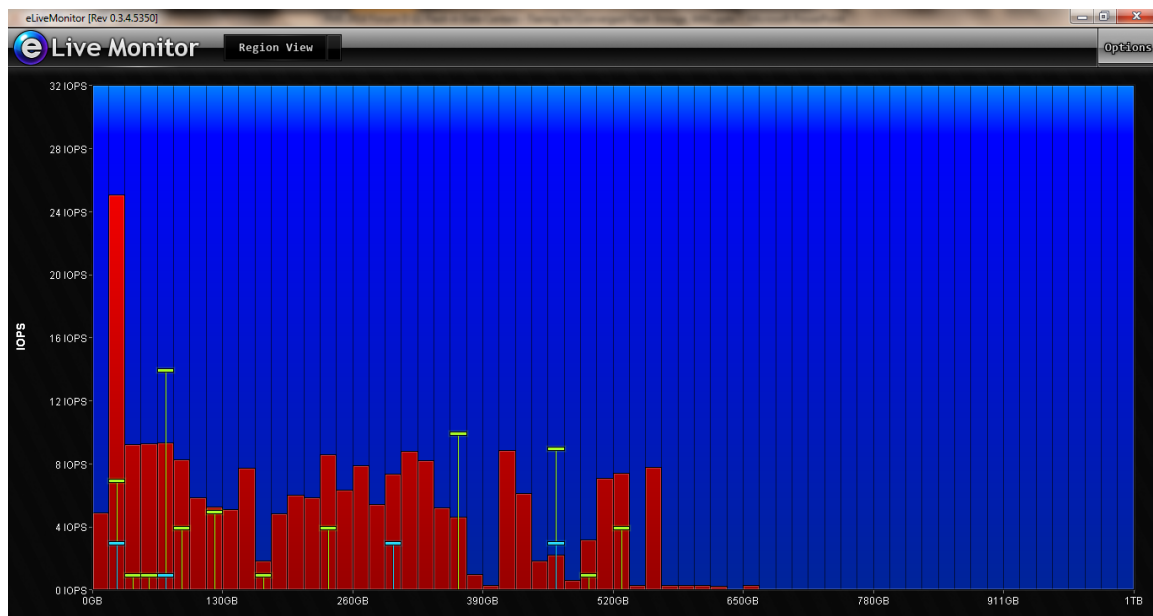


Figure 4 Visual monitoring tools enable a simple way to verify that your active data is on the fast tier as well showing how data is moved in real time

PERFECT BALANCE – PERFORMANCE, COST AND CAPACITY

Each tier, fast or slow, can be scaled independently. If the size of your active data set grows, more flash can be added to increase the size of tier 0. If you need more capacity to store the inactive data, just add more hard drives. The ability to independently scale capacity and performance allows users to tailor their solution specifically to the needs of their applications and their budgets as well. Unlike caching, a user could choose to make the SSD tier 50% of the total volume or more, if required by the application. The flexibility of tiering allows the expansion of the fast tier according to requirements and economics, but Enmotus' MicroTiering ensures even users on a budget will be able to take full advantage of SSD performance. Unquestionably, users can find the perfect balance of tiered SSD/HDD storage that will provide the full SSD experience at an affordable price.

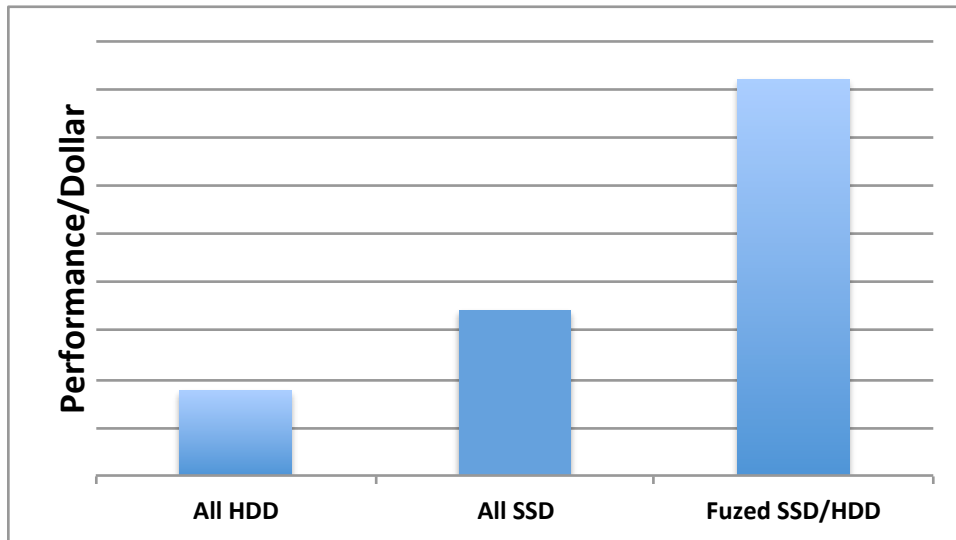


Figure 5 Hybrid storage provides the bet value in terms of Performance/Dollar



ALL FLASH HYBRID STORAGE

The economics of hybrid storage with tiering technology apply to all flash storage as well. Write intensive SLC flash has excellent endurance but at a cost significantly higher than read intensive MLC flash. Creating an all flash solution from SLC flash would provide a highly reliable solution, but at the same time, your inactive data would be stored on very expensive media. The Enmotus hybrid storage technology allows you to create a hybrid volume from various types of flash. The fast tier could be comprised of the high endurance SLC flash, and the slower high capacity tier could be made up from more economical MLC flash. The end result is a hybrid all flash solution with the performance characteristics of SLC flash, with a cost point close to MLC flash.

TIERING TECHNOLOGY FUTURE

Hybrid Storage and Tiering are typically associated with SSDs and hard drives, but the Enmotus technology is not limited to these media. The economics of hybrid storage and tiering play out in a pure SSD environment the same way they do with SSDs and hard drives. Expensive fast SSD as tier 0 coupled with cost effective SSD filling out the bulk of the capacity - resulting in a super high performance yet cost effective Pure SSD solution. Up and coming technologies such as NVDIMM, PCM Flash and MRAM promise even faster performance than today's flash technology. While hard drives may go the way of the dinosaur one day, Fast (expensive) and slower (cost effective) storage media will always exist, and Enmotus' hybrid storage software will continue to enable high performance and cost effective storage solutions.