Automated Storage Tiering
Making Good Decisions on Your Behalf

Location and Price Really Matter in Storage

Like they say in the housing market, the top 3 factors that determine price are location, location, location. The same can be said for storage real estate. Any poor choices placing data will cost you dearly, but choose wisely and the cost savings become significant.

Stick to two guiding principles and you’ll do just fine; a) Devote your fastest storage space to your most time-sensitive workloads, and b) don’t waste your premium-priced storage space on content that seldom gets accessed.

If it were only that easy. Truth is that unlike home buying habits, user access patterns change very frequently. Content that was driving interest one day becomes old news the next. And there’s no way you could possibly take the time to shuffle information around to keep up with their fickle ways. That’s where insider knowledge and a little automation come in handy.

Intelligent tradeoffs between cost and performance

The science of automated storage tiering distills down to monitoring I/O behavior, determining frequency of use, then dynamically moving blocks of information to the most suitable class or tier of storage device. DataCore™ SANsymphony™-V software automatically “promotes” most frequently used blocks to the fastest tier, whereas least frequently used blocks get “demoted” to the slowest tier. Everything else floats to the middle.

Of course, there will be exceptions, especially when you need to assign high performance storage to an infrequently used volume, as in special end-of-quarter processing. In these cases, you can pin specific volumes (virtual disks) to a tier of your choosing, or define an “affinity” to a particular tier. Only if that tier is completely exhausted, will a lower tier be chosen.
The Economics of Tiers in Virtual Storage Pools

In order to appreciate the financial motivation for auto-tiering, consider the price/performance differences among the three most popular classes of disks in use today. Leading with the highest performance at the steepest price are Solid State Disks (SSDs). Next are Serial Attached SCSI (SAS) drives, followed by the most economical Serial ATA (SATA) disks.

For random disk read patterns, SSDs are said to be 25 to 100 times faster than SAS hard disk drives (HDDs) at roughly 15 to 20 times higher cost per Gigabyte. In practice, SSDs substantially reduce the number of HDDs required for heavy random I/O pattern. Just one SSD PCI I/O card may yield the equivalent of 320 hard disk drives. That’s 300 times less hardware to house, maintain, cool, and watch over.

Say the disk capacity in your data center is split among 3 classes of disks as shown in Figure 1:

- 5% Flash SSD [Fastest, most expensive] >> Tier 1
- 35% SAS HDD [Midrange, modestly priced] >> Tier 2
- 60% SATA HDD [Lowest cost, highest capacity] >> Tier 3

In general, you wouldn’t want to waste the premium priced SSD capacity on infrequently used blocks, so the DataCore software will keep the least active information on the lowest cost, capacity-optimized SATA disks corresponding to Tier 3. On the other hand, when the auto-tiering algorithms detect sustained heavy use of certain other blocks, they will naturally bubble up to the Tier 1 SSDs.

- SSDs substantially reduce the number of HDDs required for heavy random I/O pattern
- HDDs are better suited for serial I/O patterns

Unlike the narrow and often rigid classification done inside disk enclosures, DataCore storage virtualization software allows you to define tiers according to your own price/performance index. Perhaps your diverse storage pool consists of top-shelf, premium disk arrays from one vendor, mid-range RAID subsystems from another, and relatively inexpensive racks of unintelligent disk drives (JBODs). You define what constitutes each tier, relative to the other members of the pool. You may set up as many as 16 tiers, although 3 or 4 tiers are usually enough to help you make good tradeoffs.

As new storage products arrive on the market, the top rung could shift down to make room for an even higher performing, albeit costlier, disk technology.
Not Your Parent's HSM

We should make one important clarification. In contrast to old fashioned hierarchical storage management (HSM), auto-tiering is not involved in aging files to nearline or offline storage, for long term backups and archive. It strictly works on online, active disk storage, and operates at the block or chunk level. It has no notion of file systems or database structure, nor do you want it to.

Heat Map Tells the Story

One way to visualize what’s going on is to think of the data center’s storage address space as a collection of small chunks on a grid. Rather than one square per disk drive, we’ll use 128 MB per chunk in this example. This is known as sub LUN auto-tiering. If you were to color code the map according to most active chunks, you would see certain areas glowing red, indicating heavy use, whereas others might be a cool blue, signifying little use, while yellow covered everything in-between. SANsymphony-V works silently behind the scenes to promote the blocks in the hot area to the top tier and demote blue chunks to lower tiers.

Adaptive, Fine Tuning Yields Optimal Performance

Note that while you may have a very large database mapped to one or more disk drives, auto-tiering operates on a more granular level. The software only promotes those chunks in the database that merit faster disks. You don’t have that kind of fine tuning dial as an administrator.

This adaptive behavior results in the best application response for your most time-sensitive workloads.

Caching for Further Acceleration

You'll hear auto-tiering discussions debate the distinction between migration and caching as if they were mutually exclusive. DataCore gives you both, and also lets you override either for specific virtual disks when conditions dictate.

From our vantage point, SANsymphony-V adaptive caching provides acceleration across the entire storage pool; a kind of turbo-charger for any disk I/O. The caches speed up read and write requests. Frequently read blocks on a very fine scale of 4KB remain in cache to offload the back-end disks, and reduce I/O latency. Random writes benefit from write coalescing into more sequential disk I/O.

Caching proves invaluable regardless of which tier the blocks currently reside in, and tend to be react much more quickly to short term bursts.

No Manual Intervention Necessary

For system administrators, the operative word in automated storage tiering is “auto”. Set and go policies relieve you of stressful and time consuming changes to your infrastructure. There’s no time wasted in a futile attempt to get the best distribution of disks to workloads. Yet you still have overarching control through the definition of tiers and profiles. These govern how the software implements your price/performance preferences, which you can adjust as conditions on the ground change.
**Common Use Cases – From General Purpose to Virtualized IT**

Server and desktop virtualization (VDI) initiatives have spurred the urgency to automate storage tiering, largely because the blend in workloads is so pronounced that siloed practices for optimizing disk allocation simply break down. In years past, when a server was dedicated to an application, one could reasonably model and predict the best mix of storage to meet the response needs. You could make intelligent and semi-permanent decisions as to which workloads deserved the pricier disk technology. Try that with 1200 virtual machines sharing a multi-tiered SAN. You see the difficulty.

Having said that, DataCore customers can take advantage of auto-tiering across the myriad of diverse data center scenarios, whether fully virtualized IT environments, private or public clouds and more conventional physical configurations. Again, it’s important to recognize that SANsymphony-V automates tiering across not just different disk technologies, but across different, often incompatible models of storage devices regardless of manufacturer.

**No Special Hardware Required**

DataCore implements auto-tiering software outside the storage systems, rather than confining it to any one of them. It requires no special hardware. The latest SSD technology may sit side-by-side with your legacy hard disk drives. SANsymphony-V simply takes over the control with equal ease.

**Can’t do without it**

Now that storage represents the largest single cost in the IT infrastructure and the most critical element in the overall performance of virtual environments, intelligently managing how disk space gets allocated becomes paramount. The automated storage tiering feature built into DataCore SANsymphony-V, along with the entire suite of device-independent storage virtualization services helps you maximize the utilization, performance and availability of those precious assets.

**AUTO TIERING – HOW IT WORKS**

- Monitor I/O behavior for groups of disk blocks (chunks)
- Compare access frequency against average for each tier
- Promote or demote chunks to most suitable tier

**Tier 3**

BELOW average moves DOWN a tier

**Tier 2**

**Tier 1**

ABOVE average moves UP a tier

**Chunks**

**About DataCore Software**

DataCore Software develops the storage virtualization software needed to get the highest availability, fastest performance and maximum utilization from storage resources in physical and virtual IT environments. It provides the critical 3rd dimension on which the success of server and desktop virtualization projects hinge, regardless of the models and brands of storage devices used.