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A CMI Business Brief White Paper:

Is There Flash in Your Future?

By Jeff Guenthner, CMI Director Solutions Architecture

Long a valued feature of smartphones and tablet PCs, flash memory was a pricey luxury for most enterprises until recently. However, as prices continue to fall, flash can now be a cost-effective solution for your Tier 1 and Tier 2 storage needs.

For over a decade, consumer electronics have pumped up performance and reduced footprint size with flash memory, but the price of these solid state devices (SSDs) put their lean and green benefits beyond the reach of most enterprises. In the last few years, however, the cost of flash has fallen far enough to make it economically viable for more organizations. In short, flash has reached an economic tipping point, thanks to its lower cost, the growth of data and the need for enterprises to gain insights from these avalanches of data.

Today, disk-based storage arrays are creating serious performance bottlenecks.[i] In terms of performance, magnetic drives have done a yeoman's job for many years, but we've now reached the limits of what a mechanical technology can accomplish. As enterprises increasingly operate at digital speed, storage needs to keep pace. Compared with hard disks, flash storage can read data 100 times faster while consuming about 20 percent of the power, which is why businesses already use it for I/O intensive applications such as Oracle databases, credit-card processing systems and stock trading operations.[ii] As these businesses have discovered, legacy storage solutions are no longer adequate for cloud computing, broad virtual deployments and intense transactional application demands.

Heeding the Need for Speed
During the last 10 years:

- CPU performance has increased by eight to 10 times.
- DRAM performance has risen by seven to nine times.
- Network performance has increased by 100 times.
- Bus performance has grown 20 times.
- Disk performance has lagged, *rising by a factor of just 1.2.*

Why? Because disk storage is the only data center component that is still mechanical rather than digital. This is why storage has emerged as one of the highest costs in virtualization budgets. In an effort to support broader virtual deployments and overcome storage-based bottlenecks, many organizations "bolt on" disk after disk to general-purpose storage devices – an approach that requires significant additional hardware, energy and space.

Consequently, flash memory is becoming a more attractive Tier-1 option for hierarchical storage management, allowing IT Managers to automatically move data between higher-cost, higher-performance flash drives and lower-cost, low-performance disks. The IBM all-flash system is 1U, generally referred to as "pizza-box" sized, and can be configured with 20 terabytes at a cost of about $10 per GB. High-performance disk storage systems, meanwhile, require up to four times the space to provide similar capacity, and can cost $12 per GB or more.[iii]

WHAT IS FLASH STORAGE?

Flash devices store data at speeds exponentially faster than spinning disks using a fraction of the power. They also reduce cooling, floor space and software expenses.

Unlike hard-drives, flash devices have no moving parts and are "nonvolatile," meaning they retain data even when they're not connected to a power source. Although flash is incredibly fast the first time it is used to write data to cell groups, the speed decreases when it writes to storage over time. Flash systems also offer a more limited number of read/write cycles than hard drives before wearing out. Depending on your application workload and level of writes, you may experience a lifecycle of seven years or more for a flash-based solution.

Flash memory began with single-level cell (SLC) data encoding (where each storage transistor encodes a 1 or a 0). Multi-level-cell (MLC) refers to a device's ability to store *two bits* of information per cell instead of one. A typical SLC NAND flash has a write endurance of 100,000 cycles, while SLC NOR offers about 1 million cycles. In sum, SLC has better write endurance while MLC is more cost-efficient.[iv]

Flash to the Rescue: Successful Deployment and Use Case

A global technical services company needed a new ERP application stack designed from the ground up. While the new solution was being built, however, the company had to squeeze higher performance from its existing system by leveraging as much of the existing infrastructure as possible.

This posed an interesting technical challenge: The company had already made a large investment with its existing storage vendor. Although the performance of the vendor's offerings was "good-enough" for most users, the cost to scale it was unacceptable, and the CIO wanted to have the new ERP stack in place by the fourth quarter of 2012.

The Solution? After analyzing the company's Oracle AWR reports, CMI achieved a 10x improvement in performance and a 2x CPU utilization increase by moving to flash. Based on reports and testing, CMI determined that the client could move the current Oracle environment from five CPUs to just one without impacting performance.

Result: Savings from the Oracle license and maintenance fees came to almost $320,000 per 20TB of flash deployed. Thanks to these savings, the company was able to deploy 120TB of flash storage.

Enterprise MLC (eMLC) is a type of multi-level cell flash that's been enhanced to accommodate more write cycles than consumer-grade devices. eMLC has greater endurance and can tolerate the types of workloads that enterprise applications require. Today's eMLC is ideal for organizations building large database applications – those that require lots of speed as measured in Input/Output operations per second (IOPS).[v]

eMLC is also ideal for organizations that require consistent performance, such as ecommerce sites, as well as those using high-definition video streams. To achieve similar speeds and consistency with mechanical disk drives (via "disk striping," which spreads data over multiple disk drives), companies have to add many extra disks, because each extra disk provides just a few hundred additional IOPS. (This is why spinning disks can actually be more expensive in high-performance data environments.) Unfortunately, most of the space on the extra disks isn't fully utilized. In fact, the majority is wasted. Using flash storage, IT departments can obtain thousands of additional IOPS with just one device. Obviously, this saves money on software, though the per-unit cost of the flash device is higher.

USING FLASH IN YOUR STORAGE STRATEGY

You may be asking yourself, "Should I continue investing in hard-disk based solutions for Tier-1, Tier-2 or other Tiers in my current storage strategy, knowing the advantages of flash?" Put simply: yes. While Flash does provide unparalleled performance and consistently lower latency, making it an attractive alternative for Tier-1 and Tier-2 replacement, you should still invest in disk-based solutions. There are three primary reasons for disk, based on our analysis working with clients' storage environments:

1. Applications and price performance where the cost per GB and TCO favor hard drives.

2. Off-loading 'cooler', less accessed data from Tier-1 or Tier-2 to higher-capacity SAS and NL-SAS. This is concept commonly referred to as automated data tiering.

3. For applications that do not require extreme performance (high IOPS and low latency), the performance from disk-based solutions is "good enough."

A Flash Solution Implemented without Downtime

A $2 billion specialty retailer needed faster BI reporting. The CEO's goal was to have business intelligence reports delivered by 6:00 a.m. rather than having to wait until 10:00 for the business-critical information.

Unfortunately, the firm's existing storage solution was taxed to the limit. It couldn't handle additional work without a major upgrade, and the firm couldn't afford the downtime needed to overhaul an environment whose total data was 80TB … and growing. To achieve the CEO's goals, CMI implemented a flash solution that migrated the 4TB data warehouse from the existing storage system without downtime.

Result:
- Migrated the client's data warehouse from the existing storage to the flash with no downtime.
- Reporting processing time was improved by 18x, cutting four hours off batch reporting runs.
- Boosted overall application performance 3x through increased CPU utilization and leveraging the low latency of the new flash solution.
- The client's existing storage solution remains in place, but now has new life because the most demanding workload is being handled by flash.
- Storage Productivity Center: This storage resource management solution let you control your entire storage infrastructure through a single interface, including mixed-vendor storage systems.

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If you have applications that fit one of these three categories, then an all-flash solution in your Tier-1 and Tier-2 may not provide you with the best TCO. Instead, investigate the use of flash to improve the performance of applications that can benefit most. With that in mind, let's explore the economics of flash based on client uses cases.

THE ECONOMICS OF FLASH

For example: IBM's FlashSystems Model 820, which is 1U, can be configured to provide 1 petabyte of data in a single rack, and is capable of producing 22 million IOPS. Obtaining that same level of storage and throughput from a hard drive system would require 315 racks of high-performance disks.[vi]

Interestingly, the cost of adding flash storage actually decreases as need for capacity increases, but the opposite is true of hard disks and in-memory databases. As hard-disk memory density increases in servers, the cost of the memory dramatically increases. And as the amount of memory rises, so (usually) do the number of processors needed. And as the number of processors and memory capacity increases, so do the costs of licenses and maintenance.[vii]

DO YOU NEED FLASH?

To determine whether flash memory is optimal for your organization, first determine whether the source (or sources) of performance bottlenecks are a result of compute, network or storage I/O issues.

In the case of Oracle, ask your database administrator for an Oracle AWR (Automatic Workload Repository) report. These will supply the statistics needed to pinpoint the most pressing problems within an Oracle database environment. If you provide the report to CMI for analysis, we will identify the improvements that a flash solution can provide.

Typically, an Oracle environment will see a threefold to eightfold improvement in I/O waits. In addition, you will see higher CPU utilization per system, meaning you will get more work done with the CPUs you already have. In enterprise applications, flash can also help to reduce the biggest line item costs of hard-disk drives – for licenses and maintenance. For example, if you're running Oracle on 4 cores today, you'll pay $20,000 per core in license costs and $4,000 per core in annual maintenance: a total annual price tag of $96,000. With a flash storage solution, you can eliminate 2 cores of Oracle for a 50% savings.

Hard Disk vs. Flash
License and Maintenance Costs

Hard Disk

$96K

Licensing
$20K/core
x 4 cores

Flash

$48K

Maintenance
$ 4K / core
x 4 cores
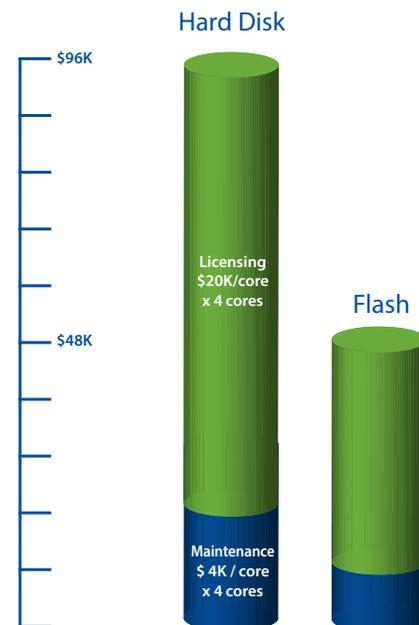
As data demands grow with the increasing use of social and business analytics, business performance bottlenecks are moving to the storage infrastructure, so in many cases, the savings from doing smarter business compensate for the cost of adding flash.

CONCLUSION

As the price of flash memory drops, it is becoming more cost-effective to use for Tier-1 and Tier-2 storage. In turn, this reduces the amount of physical space and energy required by the average data center. Although the line-item cost of flash memory can be higher (for now) than hard disk drives, the lower TCO (total cost of ownership) can quickly transcend the initial investment. For example, if your organization has a significant investment in an existing enterprise platform, adding flash as a Tier-1 to your array could be a good idea, since it obviates the need to manage multiple arrays and can provide more than 100TB in a single rack.

IT experts and industry analysts may disagree on the extent to which flash memory systems will take control of primary storage, but it's a safe bet that flash will have a much larger role to play in enterprise data centers in the near future.

For more information, please contact me at jeff.guenthner@cm-inc.com.

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[i] Dave Rosenberg, "Flash storage too good to resist." Cnet, February 15, 2012.

[ii] "Flash Storage." Techtarget.com.

[iii] Michael Vizard, "How Flash Memory Could Shrink the Data Center." Slashdot, April 30, 2013.

[iv] "Flash Storage." Techtarget.com.

[v] "Enterprise MLC." Techtarget.com.

[vi] Joab Jackson, "IBM bets $1 billion on flash storage."

[vii] "In-memory databases versus flash arrays." White Paper, IBM Systems and Technology Group, 2013.

Status Check: By John Wondowlowski, CMI's Chief Technology Officer

It is impossible to pick up a trade journal or receive a vendor's email without reading about data growth. The need to store and access enterprise data is continuing to expand at rates that are amazing. But back in the I.T. Department we need to not only store and protect that data – we need to make it accessible to a wide variety of constituency … at on-demand speed. Our "users" do not know what data they need to access this afternoon – they just have high expectations and high demands.

I have come out of meetings with Senior Executives where 'the business problem' was that the "Dashboard Reports were not available at 7:00am Eastern Time". After my Business Intelligence colleagues were able to push me into the street and I was wearing the tread marks of two large bus tires on my back– I found that there was a solution.

After I realized that pre-soaking my shirt to try to remove the tread marks was not a viable solution – I turned to the technological problem of moving stored data quicker and more efficiently. The primary technological issue facing I.T. Groups has been how to leverage current technology to store data in a way where it can be accessed (and potentially modified) by an array of users and use-cases in speeds that are acceptable to the business users.

We all realize that Storage Arrays have physical limitations – a disk can only spin as fast as a disk can spin and processors can only process data as fast as they can process data. But in today's world – the cost and utility of Flash Storage has become a key enabler for I.T. Departments. The speed of access fits the needs of I.T. Leaders and Data Consumers in the enterprise, and the cost models are becoming compelling.

Flash has a vital role in nearly every enterprise Storage Strategy – when placed into a broader strategy of access speed requirements – balanced with read/write realities – Flash will continue to carve out a larger role in the Enterprise Storage Management Landscape. The key for any enterprise is to fully calibrate and understand storage (and data access) requirements – and then to provision tiered storage that meets those needs. The price-point and reliability of Flash Storage today gives I.T. Departments another offering that can really help in this day and age of exponential data growth.

Trust me, the buses lined up at the street corner – just ready for me to be pushed in front of them – continues to grow. But we have earned some credibility with Flash Storage and I think there is a use-case for virtually everyone where your life will become easier. Also – wear dark colored shirts as the bus tire tread marks are a bit less visible.

Until next time,
John Wondowlowski
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Reality Check: A CFO Reviews this White Paper

I have worked as a CFO in both Visual Effects and Video Game companies, industries that often set the pace for IT technologies and foreshadow the challenges facing scalability of IT infrastructure in other industries.

In the digital entertainment sector, rising quality of displays and processing power has increased the volume and size of art assets required to make a piece of hi-definition content, with memory and storage facing the largest challenge.

With the growing digitization of content,all companies are storing more data, and hard drives are a significant cost in most companies that use any form of centralized storage. It is a cost that is often underestimated. I lost count of the number of times we started to max out our storage and was told by someone that "I just bought a 500GB hard drive at Best Buy for $129." A networked hard disk array that stands up to commercial demands from 50+ employees is a completely different product, and a costly one.

While offsite "cloud" storage helps in many ways, it also creates new operational challenges. Having data stored and accessible in a single cloud location from all offices increases the number of times a single storage device is accessed each day, which increases failure rates and exposes shortcomings in the speed of mechanical drives – storage becomes the "bottleneck".

 To use an example from the VFX world, when we moved to cloud based storage to support multiple offices, we had individual files being accessed over 5,000 times a day, which created major productivity issues and significantly increased failure rates. The hidden cost of expensive artists being slowed down was no longer hidden and it became a quantifiable operational problem. It may seem like an extreme example, but with the speed of mechanical hard drives not keeping up with other digital parts of IT infrastructure, the same problem is now applicable to other industries.

Our solution was to build a tiered storage strategy that included all types of storage devices and included a flash based caching system for the most frequently accessed files. This decision resulted in major cost savings even though at the time the flash based arrays were, gigabyte for gigabyte, more expensive than an equivalent hard disk solution. It literally saved us full percentage points of margin.

The cost of hard disks has been rising and they are not keeping pace with the speed of other parts of the IT infrastructure. The new standard IT architecture is moving to the cloud, placing increased strain on storage efficiency and reliability. With the cost of flash memory falling, some elements of flash memory in the overall storage strategy now makes a great deal of operational and financial sense. It is definitely something worth exploring.

Best of Luck,
Kevin

Kevin Weston. President – Float Hybrid Entertainment. Former CFO Digital Domain Productions, VP Finance and Operations of LucasArts and CFO/SVP Finance and Operations at Eidos Interactive Inc.