

DISK IS DEAD

& NO SSDs

TAKE
A TRIP



FROM SHOCK



AND DENIAL

TO ACCEPTANCE
AND HOPE

violin[®]
MEMORY

DISK IS DEAD **& NO SSDs**

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FOREWORD

by Jon Bennett, CTO and Co-Founder, Violin Memory



WELCOME

We are about to embark on a journey of discovery together.

Well, that's not completely accurate. You and I have already been on this journey for some time. It is a journey from old to new. From ineffective to effective. From slow to fast. From painful to fun. From shock and grief to hope and acceptance.

In this collection of essays, we're going to take a look together at several perspectives on the statement: "Disk is Dead". Take the trip with me. It will be worthwhile. You will learn some useful tips and hopefully, start thinking about when it makes sense for you and your organization to start moving your storage infrastructure to flash.

DISK IS DEAD

The context for this statement is the long-felt performance gap between storage and the memory and processor resources in a modern data center. While silicon based resources have been shrinking and accelerating along the lines

of Moore's Law, state of the art storage has been based on an almost 60 year old technology. 60 years? Really? To put all of this in a context, let me ask you a couple of questions:

When was the last time you used open reel audio tape? 8-track tape?

Last time you recorded music on a cassette tape?

Recorded your home movies on film?

Shot your holiday pictures on film?

Recorded video on a VCR?

On tape?

Used video recorder with a hard drive?

Owned an iPod with a hard drive?

Used a floppy disk?

Used a cell phone with a hard drive instead of an SD card? (Yes, there were actually cell phones with hard drives, I know it sounds crazy but it's true).

I bet you think you can see where this is going: You have set aside obsolete technologies in your personal life often in the recent past, just as soon as a better solution is available and proven.

Now let's bring the question a little closer to the workplace: When was the last time you used a laptop with a hard drive?

Wait... what was that? Really? You still have a laptop with a hard drive?

Ok, stop reading this and go find someone with a laptop with an SSD and ask them to run a search of their email for something. Ask them to launch a dozen apps. Ask them to sleep and resume.

Yes, I'm serious.

Yes, I'll wait.

Pretty amazing huh?

If you want to see really amazing go try a new Macbook Pro with Apple's custom PCIe attached controller

But you probably already have one don't you? Not ever going back to a hard drive are you?

So why are you still buying hard drive storage?

Each extra minute of VDI login time during the morning boot storm is 2 lost work days per employee over the life of the storage.

If you would never use a PC with a hard drive, why would you use a hard drive for your virtual PC?

Why would you use one for your VSI/general purpose storage needs if you wouldn't use one for something as boring as desktop apps?

COST?

HDDs have a lower \$/GB you say? Well 5k RPM SATA drives have a lower \$/GB and you aren't using those, heck tape is under a penny per GB and you aren't using that.

Ah, so it's not just a question of \$/GB, paying more for the performance of those SAS drives is worth it for the benefit they provide. So again, why are you buying hard drives and not flash?

You don't think you need that much performance? Think again.

Each extra minute of VDI login time during the morning boot storm is 2 lost work days per employee over the life of the storage. Every 10 seconds of extra login time in a hospital or point of sale environment is a WEEK of lost time per

employee over the life of the storage. The HDD system could have a price of \$0 and its cost to the business will still be higher than flash.

What is the cost of not getting reports till the next morning instead of having them in real time? The cost of not actually processing all the data you want to look at? Not asking all the queries you could ask?

How about the cost of all those extra servers and licenses you need? All the operational inefficiencies you put up with to use disks, having to run against copies of the database because you can't run against the live copy. Having to buy extra storage for those copies. Only migrating applications on the weekend because your storage doesn't have any spare I/O.

You know you don't actually want to use hard drives, they're dead; get yourself a Violin FSP and let your storage come alive.

Every 10 seconds of extra login time in a hospital or point of sale environment is a WEEK of lost time per employee over the life of the storage.

THE DIFFERENCE

Oh, and why did I tell you to check out a MacBook and not just any laptop with an SSD? Because just as there is a big difference between slapping an SSD into the HDD slot of a laptop and having a purpose built flash controller directly integrated with the host OS, so too there is a big

difference between slapping SSDs into a disk shelf and claiming it's a system designed for flash, and having a system that actually is designed for flash. Let us show you the difference.

We have talked about our willingness to jettison obsolete technologies such as 8-track tape when a better solution comes along. I think we can all agree that it makes no sense to buy a laptop today with a hard drive in it. For the same reasons, it makes no sense to buy HDD for a data center anymore.

WHAT LIES AHEAD

In the chapters that follow my colleagues will share their thoughts on the various reasons disk is dead or should be as a primary storage platform. They will look at the impacts emotional, technical, financial, and strategic of clinging to disk for too long and at the benefits of beginning or accelerating your own personal journey to the all flash data center of tomorrow. Enjoy the trip.



1



SHOCK – DON'T TRIP OUT... IT'S ONLY ROCK AND ROLL

by Amy Love, CMO, Violin Memory



DISK IS DEAD

This is the first in a series of essays on the topic of “Disk is Dead”. If you’ve been truckin’ around data centers for any amount of time you’ve seen your share of old IT stuff being replaced with new, better IT stuff. However, up until now the one thing that’s been constant has been the disk drive – kind of like the standup bass was before Rock and Roll was electrified.

So don’t be shocked when I tell you spinning media’s days are numbered, too. Yes, the concept that Disk Is Dead as primary storage is near. The times they are indeed a changin’.

While still a multi-billion dollar business, disk drives as the primary IT data storage medium are being replaced by flash. The “concept” of the all-flash data center within a very short window is becoming the “reality” for business in competitive

markets. Just as the Stratocaster and the Les Paul became the de facto guitars for just about every rock band, flash storage will be the heart and soul of tomorrow's 24x7 data center.

There's a stairway to flash heaven, and I think it's going to come from a different and better "clean sheet architecture" approach that optimizes the inherent capabilities of flash and provides solutions that can simultaneously provide advanced data services, performance, and density.

IMITATORS

Reminiscent of the British invasion of the '60s, today we're seeing a multitude of look-alike vendors offering look-alike flash solutions. Most are bundling SSDs – solid state drives; some still putting them in boxes with disk drives, to cobble together complex, tiered, hybrid arrays. The real question in my mind is who will climb to the top of the flash charts; which company has the wherewithal to meet the ongoing needs of today's IT customer, and which will be just a one hit wonder? And more importantly, which storage vendor will become the Les Paul or the Stratocaster of flash storage solutions? Who will create the instrument that captures the imagination of today's IT generation — my generation?

I do believe that there's a stairway to flash heaven, and I think it's going to come from a different and better "clean sheet architecture" approach that optimizes the inherent capabilities of flash and provides solutions that can simultaneously provide advanced data services, performance, and density. I'm proud to be part of Violin Memory, a company that is the pioneer in this aspect, providing an effective and efficient approach for contemporary and nascent data center needs with our latest 7300 and 7700 Flash Storage Platforms.

FROM FLASH TO FLASH

Last night, I pulled up Spotify and "Uncle John's Band" by The Grateful Dead came on. It made me think of the transformative progress of media data – from vinyl records to cassettes to CDs to MP3s. But for most of us today, if you want a Grateful Dead song, you get it from – and store it on – flash. Jerry Garcia would likely be "spinning" in his grave to hear of anyone not moving the same way for all their active IT data. Disk may be dead, but don't trip out – it's only Rock and Roll, but I like it.

And you will like the perspectives that follow from my colleagues on the leadership team here at Violin Memory.

HIGHLIGHTS:

Spinning Media's Days are Numbered

Disk is Dead as Primary Storage

SSD is Just a Flash in the Pan

The Best Results will Come from a "Clean Sheet Architecture" Approach

2



DENIAL—DISK IS DEAD.

Denying It Can Slow Your Business Down, Cost Your Company Millions, and Make Work Miserable

by Susan Scheer Aoki, VP Customer Experience, Violin Memory



STORAGE PROBLEM?

What storage problem you ask? You don't have any storage problems...

As IT professionals, you have a lot on your plate. You need to oversee cloud and in-house application requirements to support demanding users. You manage day-to-day operations with service level expectations. Your staff tunes performance, ensures availability, maintains security, and researches emerging technologies. It's a lot to accomplish in a 24-hour day.

One of your biggest challenges is managing data center sprawl. With today's tight IT budgets, it's a huge challenge to enable the business with data growth and avoid consuming the limited budget in floor space, HVAC, and power in the data center.

WHAT IF...

Let's consider the following hypothetical: You require 100TB of general purpose storage to come online in the next 90 days. This storage must deliver 500k IOPS at a 70/30 read write ratio. Your legacy storage vendor quotes a configuration that requires over 100RU to house 1250 Hard Drives.

Since you are required to short stroke the drives to get the targeted performance, you only get to use the outer 20% of the drive, and 80% of the 750TB raw capacity goes racked, powered, cooled and unused. Of the remaining 150TB, RAID data protection will consume at least 20%, leaving approximately 120TB of useable capacity available in a ~2.5 rack footprint containing the 1250 Hard Drives...

Your legacy storage vendor recommends a configuration that requires over 100RU to house 1250 Hard Drives, comes on a quote that is six line items deep, lists out at \$2.5 Million Dollars and doesn't include deduplication, compression, stretch clustering for disaster recovery, services or maintenance.

All of this comes on a quote that is six line items deep, lists out at \$2.5 Million Dollars and doesn't include deduplication, compression, stretch clustering for disaster recovery, services or maintenance.

If you run any database applications, you probably also have DBA staff monitoring and managing

general application and mission critical database performance, manually placing data and logs to maintain SLAs. Another layer of cost and complexity. And somewhere in there you have staff dedicated to opening LUNs, managing capacity, snapshot, replication and clone policies, resources, capacities. That's a problem. Can't be denied.

And what about service and maintenance for this big, complicated, inefficient HDD-based array from a mega vendor who has – probably – cobbled a solution together from several different technologies coming from a series of acquisitions?

BAD OPTICS

It might appear to an outsider that data center space is being wasted; sprawl doesn't look like it's under control; IT budget and natural resources to deliver acceptable levels of performance, capacity and data services, propped up by legions of administrators doing ground-level, finger-in-the-dike, block-and-tackle system support just to keep the lights blinking. Complicated. Expensive. Fragile. Those are problems.

After working through the denial that a move to flash is required, the next question becomes: What features should you be looking for? For example, it is widely understood that the performance of a fully redundant flash fabric architecture supporting a storage operating system that integrates ship-level access and user level management tools eliminate the need for complex tiers of storage technology. Why cache? Why tier when everything can be on flash?

THE IDEAL ARRAY

The ideal flash storage platform will also host a wide array (pun intended) of data protection and data efficiency services – users switchable in line deduplication and compression thin provisioning, snapshots, clones – to name a few. Scalability, replication and

stretch clustering should also be at or near the top of your list of critical features.

A well designed flash storage solution will never need to be “short stroked”. You will never again see the kind of waste you’ve been forced to accept in the past – buying 1250 HDDs in 2 or 3 racks to get 100TB of useable capacity at the required performance level. Never again.

A well designed flash storage solution is the antidote for server sprawl. What used to take 100RU to deliver using legacy storage, can be delivered in 3RU, and it is 5X faster.

You become the IT hero for your users and for the business like the teams at Dick’s Sporting Goods and Tyson Foods. Dick’s saw their application performance improve 5x while Tyson Foods saw a 3x improvement in application performance. No denying the impact that can have on an organization’s productivity.

Already, well designed flash storage platforms have allowed customers around the world to consolidate resources in their data centers – in many cases to consolidate entire data centers at the same time they eliminate fragility, eliminate complexity, improve VM densities, application performance and end user productivity, and free up IT staff resources to find and develop competitive advantages hidden in the data center.

BUSINESS IMPACT

I know one customer in the technology sector who has been able to raise performance levels across its organization while consolidating 21 data centers down to three. Another customer in the health care sector is adding DR capabilities with a remote data center while upgrading the infrastructure they use to host their Meditech EHR applications, in part based on the performance, capacity, data

protection and simple management of Violin All Flash Arrays and Flash Storage Platforms. Moving to a simple, high value, high capacity, and high performance all-flash solution sounds great, right? No denying that.

And on the service side, Violin provides the services and support that help customers optimize performance, and return on invested capital, reverse data center sprawl and transition successfully to the all flash data center necessary to meet today’s and tomorrow’s business challenges. No denying that, either.

All in, there is no denying that moving to flash storage for active primary workloads from Violin is a smart, cost-effective play that will simplify your storage, simplify your data center and simplify your business.

Thank you for joining me as we consider the costs of denying that Disk is Dead. I believe your quality of life, your career and your business will all benefit from the performance, simplicity and efficiency of taking another step on the road to the all flash data center.

HIGHLIGHTS:

You’re a busy IT professional with a lot on your plate and limited resources.

Your next storage refresh will cost you millions from a legacy vendor.

The solution will be complicated, expensive and fragile, unless you consider flash.

What used to take 100RU to deliver using spinning media is now available in 3RU, and its 5x faster.

3



BARGAINING THE FACT AWAY: Maybe I can use a Hybrid Array as a Solution

by Steve Dalton, SVP, Engineering, Violin Memory



DISK IS DEAD

Let me repeat: Disk is dead. The best years of disk drive technology are in the past, the distant past. Not Negotiable. No Faustian bargain will bring it back to life. Even if you're "A Friend of the Devil", as the Grateful Dead would say.

It's time to let it go and visualize the data center where primary storage is free of spinning rust. It's time to move beyond racks and racks of short-stroked hard drives chugging up electricity and producing excess heat. It's time to stop compromising. It's time to reimagine the data center as an agile competitive advantage.

Unfortunately, not everyone is ready yet to let disk go.

In the bargaining phase of grief, some vendors will go to extraordinary lengths to prolong the life of disks in the data center. This is neither rational nor eco-

nomical. The best thing to do is to move on and embrace the flash revolution as have many Violin Memory customers, including two global leaders, in their respective industries, Tradition-ICAP and Australasian Performing Rights Association.

So why are companies bargaining away their future? It all starts with certain players promoting outdated technology:

EXAMPLE ONE: THE LEGACY VENDOR

These are the stereotypical “800 pound gorillas” of the industry. These companies have been around for decades and maybe even a century. The point is these vendors have too much invested in the old disk technology. Last week, my colleague Susan Scheer Aoki used one of these vendors as an example, where a 750TB disk array cost more than \$2M while producing only ~500k IOPS, with only 120TB usable.

In the bargaining phase of grief, some vendors will go to extraordinary lengths to prolong the life of disks in the data center. This is neither rational nor economical.

Sadly, instead of unleashing the full potential of flash, the legacy vendor, along with many others, chose to simply cobble SSDs to an existing disk array, resulting in a slightly faster array that serves no purpose other than preserving the revenue

stream. By my calculation, the makeshift system costs \$550k for 20TB array with only slight improvement in latency. Extrapolating the 20TB HDD+SSD hybrid to the previous 120TB HDD example, the customer will AGAIN end up paying more than \$2M. This is fantastic for the legacy vendor’s revenue stream, but offers no value to the customer.

Lower prices for all-flash solutions have already taken away any cost advantage for hybrid arrays.

EXAMPLE TWO: THE HYBRID INTEGRATOR

These are often startups that have jumped on the idea of utilizing both disks and SSDs in virtualized environments, be it virtual server infrastructure (VSI) or virtual desktop infrastructure (VDI). The concept is flawed since the effort uses off-the-shelf SSDs for fast time-to-market. However, lower prices for all-flash solutions have already taken away any cost advantage for hybrid arrays.

Additionally, with both disks and SSDs interacting (vendor unique tiering and hierarchical data movement), the overall performance, especially latency, is often unpredictable, creating latency spikes that hurt virtualized environments. Also, hybrids often lack disaster recovery and business continuity capabilities. The end result is that these products are at best point solutions that cannot serve as primary storage in the data center.



NO SSDs

Both of these examples have one thing in common: The SSD. By definition, SSD is a device that emulates disk behavior but uses memory (in this case, NAND flash) as the storage medium. Remember, a disk drive has one actuator arm and it can thus only perform a read or a write operation at any one time.

By definition, SSD is a device that emulates disk behavior but uses memory (in this case, NAND flash) as the storage medium. Remember, a disk drive has one actuator arm and it can thus only perform a read or a write operation at any one time.

That's right. The 60-year-old disk drive cannot read and write at the same time because it's physically limited. By using SSDs, legacy and hybrid vendors have bargained away a key benefit of using flash.

Forward-thinking technology pioneers, such as Violin Memory, looked at what's possible with NAND flash and developed innovative architectures that exploit the best of every piece of hardware and software in a solution design with no blind spots and no unknown black boxes.

Want to turn your data center into an agile competitive advantage? Don't let a legacy or hybrid vendor bargain it away with disk.

HIGHLIGHTS:

Disk is Dead and SSDs are not the solution.

SSD Arrays are every bit as expensive as HDD-based Arrays.

Hybrid Arrays, combining SSD, HDD and tiering software, are complex. Performance is inconsistent.

A fresh architectural approach that combines chip-level access, zero-downtime hardware and a simple, single unified software stack will usually yield the best results.

4



GUILT—I SHOULD’A BOUGHT FLASH

by Said Ouissal, SVP Worldwide Field Operations



GUILT

We’ve all felt it – the twinge in your stomach when you know you’ve taken the easy road, but in all actuality, you know it to be the wrong the road. When this happens, guilt builds up and you have that feeling of remorse.

Don’t be guilty of the same old thing

More and more often, this feeling of guilt and remorse happens when IT professionals choose to ignore the reality that Disk is Dead for primary storage. As these professionals reflect on their decision to postpone the demise of disk, they are bombarded with customer stories, about leaders in their respective industries, like Pella, which highlight the ability of flash to drive business (and career) changing outcomes.

No one wants the guilt of buying a complex, expensive solution, based on 60-year-old technology that cannot meet today’s or tomorrow’s requirements just because there is a “good relationship” with a legacy vendor. Good relationships do not win new customers or pay the bills.

HOPE

The great news for everyone facing a near term storage refresh, the economics of flash are “just too compelling” to ignore, according to the latest IDC White Paper¹. Simply put, the optimized design of a non-blocking fabric architecture such as Violin’s Flash Fabric Architecture™ delivers the benefits of flash at a price advantage over disk or even SSD architectures.

Simply put, the optimized design of a non-blocking fabric architecture such as Violin’s Flash Fabric Architecture™ delivers the benefits of flash at a price advantage over disk or even SSD architectures.

You might feel guilty about choosing a Violin all-flash solution because you’re concerned about the maturity of the solution. After all, you’ve tuned your data center to work around a proven disk technology by adding caching, overprovisioning, short-stroking, and striping to get the most from your sophisticated electro-mechanical devices. This technology is beyond mature and should have you thinking about its useful life in a competitive world. Disk really is dead.

You need the right combination of current technology and reliability. You can feel guilt-free about the maturity of an optimized flash solution since we’re now on its fourth generation. Violin shipped its first array in 2007 and just celebrated its 10th anniversary. The install base includes approximate-

ly 2000 arrays in the most demanding environments on earth, with every major industry represented. Those arrays are helping to solve the most difficult storage problems imaginable.

EMBRACE THE FUTURE

Bypass the guilt and embrace the future. Optimized flash solutions are in fact less expensive than legacy spinning storage, hybrid solutions or even SSD-based arrays. All-flash solutions are mature technology and a proven way to improve application performance and data center economics. In addition, some, based on clean sheet architectures such as Violin’s Flash Fabric Architecture offer simplicity in management and a comprehensive suite of data services, so you don’t have to compromise to move up to flash. No guilt required.

The performance you get from some of today’s all-flash solutions provide a solid platform to grow the business, improve operational efficiencies, even find new sources of revenue. Many Violin customers have experienced these benefits, and you can too. Don’t be guilty of the same old thing.

HIGHLIGHTS:

At this stage, adding HDD capacity and not Flash could be a career limiting move.

Flash Fabric Architecture delivers optimized performance and value.

You need the right combination of current technology and reliability.

¹ IDC white paper, sponsored by Violin Memory, Why AFA Architecture Matters as Enterprises Pursue Dense Mixed Workload Consolidation, (Doc # 258074, July 2015)

5



ANGRY. REALLY ANGRY.

by Cory Sindelar, CFO, Violin Memory



DISK IS DEAD

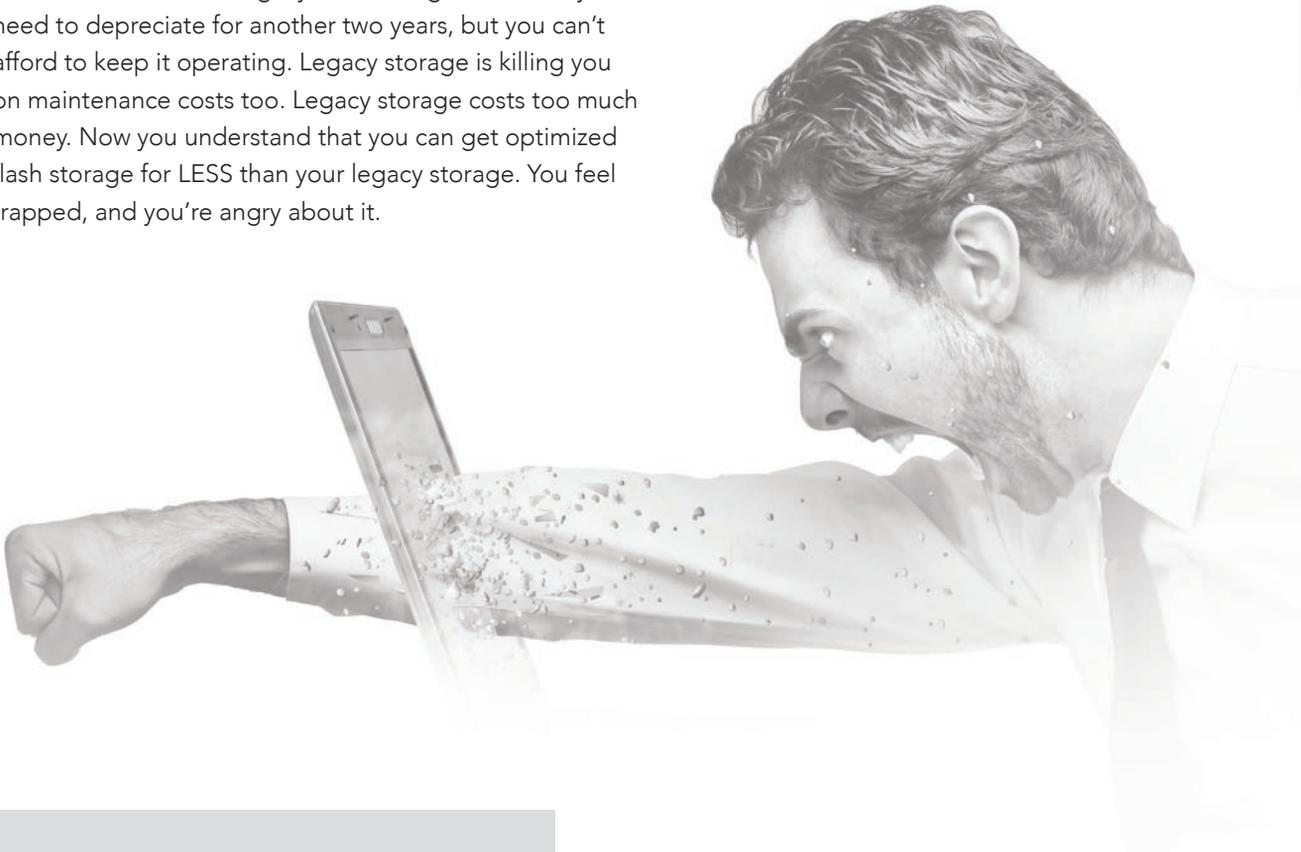
Some people might feel guilty about not buying an optimized flash platform. But a typical CFO has reason to be angry. Really angry.

As Violin's CFO, I have a detailed view of the business. We use our own storage, but not all CFOs are as lucky as I am. When other CFOs see expensive programmers sitting around waiting for their jobs to compile, they see money flying out the window. When business managers can't provide current data because they're waiting on reports, CFOs simmer. When they see 60% or more of their OPEX (people expense) underutilized, they burn. CFOs seeing their billing cycle adding a day, they explode.

The bad just gets worse. As their company grows, they get further behind. As there is more data to process, reports take longer, transactions slow, supply chains can't keep up, and they get fewer analytics runs in the same amount of time. The more successful the company, the less efficient it becomes. This is NUTS! They spend millions on storage from legacy providers, buying into the promise of a better tomorrow, but things never improve. They only deteriorate.

CAN YOU AFFORD ANY MORE SUCCESS?

You have an obsolete legacy data storage asset that you need to depreciate for another two years, but you can't afford to keep it operating. Legacy storage is killing you on maintenance costs too. Legacy storage costs too much money. Now you understand that you can get optimized flash storage for LESS than your legacy storage. You feel trapped, and you're angry about it.



The more successful the company, the less efficient it becomes. This is NUTS! They spend millions on storage from legacy providers, buying into the promise of a better tomorrow, but things never improve. They only deteriorate.

HIGHLIGHTS:

Waste makes a CFO angry.

Doubling down on dead disk technology is NUTS.

You can get optimized flash storage for LESS than your legacy storage.

DEPRESSION— DISK IS DEAD AND NOW I'M STUCK with All of These Operational Expenses

by Ebrahim Abbasi, SVP Operations, Violin Memory

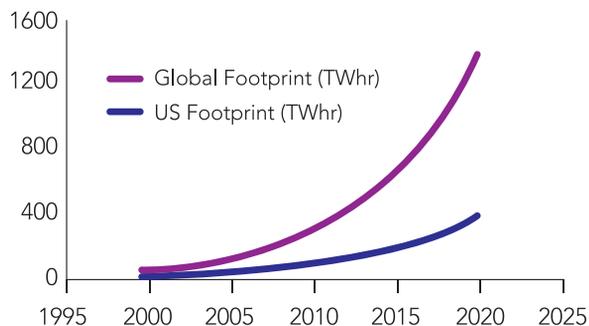


DEPRESSION

You have invested heavily over the years in data centers believing that these investments would handle all of your IT needs. Now that disk is dead, those same data centers have become your albatross, dragging down business performance and consuming valuable resources that could be better spent developing innovative applications to drive the business forward. At this point, the title of CIO almost seems to stand for “Career is over.” When anger gets directed inward, it is called depression.

CIOs today are facing the universal challenges of increasing operational efficiency and improving the customer experience through innovation. After all, companies face increased competition from a variety of new sources, and these companies are looking to technology for answers. That makes IT leaders a very strategic partner, yet a McKinsey survey shows that satisfaction with IT effectiveness continues to decline.² How could that be? Let’s look at some not-so-fun facts about the current state of IT, talk about depressing.

First, IDC expects data to grow to 40 zettabytes by 2020, this at a time when IT budgets that have been relatively flat for years show only modest increases. Second, data center growth is exploding, as are their operating costs, chief among them are power and cooling. In fact, here's an interesting chart showing the expected power consumption in the years ahead. According to an SNIA whitepaper on the TCO of Solid State Storage, energy costs will soon consume up to one-third of IT budgets.³

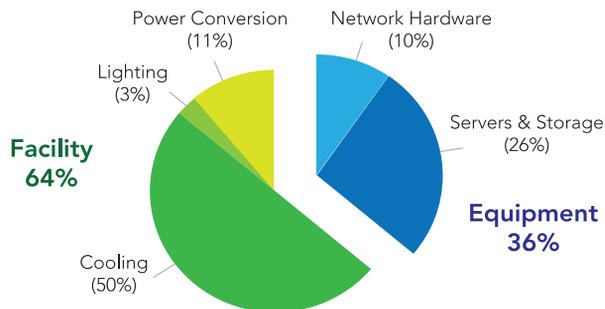


Projection of Data Center Electricity Use

...the all-flash storage array significantly reduces these operational costs, allowing those savings to be redirected to fuel innovation and prolong the life of your data center investment.

Now, couple that with a look at where all of that power is being used. Not too surprisingly, 26% is being consumed by storage and servers while another 50% is used for cooling. As equipment rack densities increase, your aging data centers are

running out of capacity to power and cool all of that equipment.



Typical Data Center Energy Consumption

FUNDING INNOVATION

With all of that money flowing into operational expenses, what's leftover for your team to innovate? That same McKinsey survey found that a mere 11% of IT spend is on activities that can drive the business forward – respondents agreed that application development is the most important activity yet is the least well executed.

Not too surprisingly, vendors are responding with yet more tools to purchase that promise to automate and improve operational efficiency through software defined capabilities. While such benefits may be within reach, the downside is that these tools also increase IT complexity, placing increased performance demands on the underlying infrastructure. Can the prospects be any more depressing? It's a vicious cycle of investment to achieve business benefits that always seem to be just out of reach. Yet, IT leaders continue to pay these costs.

Fortunately, disk is dead. Its replacement, the all-flash storage array, significantly reduces these operational costs, allowing those savings to be redirected to fuel innovation and prolong the life of your data center investment.

It's interesting to consider the case of dumping your disk and going all flash. Analyst estimates put power and cooling savings for all-flash storage around 50-80% over legacy disk storage. That certainly fits with what a leading network infrastructure company was able to achieve. Consider applying these savings to your own situation across your entire data center; now, what could you have done with all of that money?

Throughout history, man has tried all sorts of ways to treat depression. Some even work. So, do what works for you and transition to the final stage of grief – acceptance. Accept that Disk is Dead. You'll never get back all of the money you spent on operational expenses to keep your legacy rust rotating, so stop making things worse by throwing good money after bad.



Reduce Data Center Operational Costs

2 http://www.mckinsey.com/insights/business_technology/it_under_pressure_mckinsey_global_survey_results

3 http://www.snia.org/sites/default/files/SNIA_TCOCALC_Workpaper_Final.pdf

HIGHLIGHTS:

Footprint, power and cooling are throttling data center expansion.

Flash can help cut power, cooling, and floor space costs by 50-80%.

According to an SNIA whitepaper on the TCO of Solid State Storage, energy costs will soon consume up to one-third of IT budgets.





ACCEPTANCE AND HOPE

by Kevin DeNuccio, CEO, Violin Memory



THIS STORY IS ABOUT ACCEPTANCE AND HOPE

Acceptance for the fact that disk is dead as a platform for primary storage and hope for the future of storage, of the data center, and of the competitive enterprise.

Over the chapters so far in this collection of essays, several members of the Violin leadership team have shared their thoughts on the idea that disk is dead. This idea applies to a technology no longer able to support the performance needs and use cases of today's and tomorrow's applications.

WE HAVE LOOKED BACK

We have looked at the cost of denying that disk is dead. We have looked at the compromises necessary to force a complex, inefficient, expensive, slow HDD-based array to rise to the requirements for a typical enterprise data center environment. We have looked at the anger users feel when reports take too long to run, when analytics aren't timely, when data protection is inadequate and losses occur.

For many years, disk technology was kept alive by increasing the amount of data stored in a given space, the idea of areal density. Over the last several years, the

rate of improvement in areal densities has flattened which means the cost curves driven by densities are also flattening. Soon the days of more disk space for less money will be eclipsed.

At the same time, the cost curve for flash, driven mostly by consumer applications and Moore's Law, is plummeting, expected to drop another 75% per gigabyte sometime in the next twelve to eighteen months. While disk has run out of gas technically, flash costs are falling fast and densities are rising geometrically.

NOW WE MUST LOOK FORWARD

We are at the point in time right now where flash storage offers 10x the performance for less than the cost of comparable HDD-based capabilities. All the data protection, availability, reliability, and ease of use issues have been addressed, and people are beginning to realize, from an operating expense perspective, flash is a real bargain.

Flash is transforming the ability of enterprises – entire industries, really – to grow existing revenue streams, find new ones and make better decisions faster.

We at Violin have documented use cases showing flash storage can reduce transaction time in banking environments (more revenue), accelerate inventory reporting in retail (more revenue) and deliver data usage alerts – and upgrade opportunities – in wireless telco environments (more revenue).

Beyond the opportunities to grow revenue by using flash for primary storage, business leaders are also seeing the significant favorable impact of flash on CapEx and OpEx when the I/O bottleneck is removed. Total Cost of Ownership (TCO) savings can be huge when lower IT resource and facilities costs are considered.

The densities available in flash storage today and the roadmap for tomorrow mean CIOs can deliver today's application performance needs, cut power and cooling costs, consolidate the storage footprint

in their data centers, and be well positioned to support data growth for years to come.

Flash storage platforms deliver performance and enterprise-grade data services, including user selectable block-level, inline de-duplication and compression on a single, simple, powerful platform architected for zero downtime and zero data loss at end-user costs that compete with traditional disk array prices.

Flash is transforming the ability of enterprises – entire industries, really – to grow existing revenue streams, find new ones and make better decisions faster.

We have hope for those leaders who see the inevitable benefits of moving to flash for primary storage, for active tier one and tier two workloads, and we fear for those who don't because they will lose the ability to compete effectively in tomorrow's marketplace.

HIGHLIGHTS:

Flash costs are falling fast and densities are rising geometrically.

Flash now offers 10X the performance for less than the cost of HDD-based arrays.

Data protection and data efficiency services are now on par or better than HDD-based services.

Moving now to a Flash Storage Platform can open up revenue opportunities and reduce CapEx and OpEx.



BRING OUT YOUR DEAD

by Amy Love, CMO, Violin Memory



IT'S BEEN FUN, BUT...

We have had fun over these last several chapters, riffing on Disk is Dead and giving away tickets to see the Grateful Dead. Now it may be time to take action, to bring out your dead and dying disk arrays.

But on a serious note, be cautious as you move down the path of researching, testing, and integrating flash into your data center. You will see a multitude of look-alike vendors offering look-alike flash solutions, almost like tribute bands, imitations, however well-intended, just not the real thing. These are often startups that have jumped on the idea of utilizing both disks and SSDs in virtualized environments, be it virtual server infrastructure (VSI) or virtual desktop infrastructure (VDI).

THE REAL THING

The concept is flawed since the effort uses off-the-shelf SSDs for fast time-to-market and alleged "commodity pricing". However, lower prices for all-flash solutions have already taken away any cost advantage from hybrid arrays. None of them are

the genuine article. None of them are Uncle John's Band. There is simply no need to compromise with dead-end, black-box SSDs or hybrid arrays.

I do believe that all of the complexity, cost and inefficiency of legacy arrays will be overcome one day. That day will be soon. It's going to come from a different and better "clean sheet architecture" approach that optimizes the inherent capabilities of flash and provides complete solutions: This approach can simultaneously provide advanced data services, performance, and density, delivering an effective and efficient foundation for current and emerging data center needs. Violin's 7300 Flash Storage Platform and 7700 Flash Storage Platform are excellent examples.

Lower prices for all-flash solutions have already taken away any cost advantage from hybrid arrays

HDDs are being replaced as the primary IT data storage medium. The all-flash data center is already a reality for many businesses in technology,

in retail, in healthcare and in financial services, with research and proof-of-concept testing happening now across many more industry segments. Just as the Stratocaster and the Les Paul became the de facto standard for just about every rock band, Flash Storage Platforms will be the heart and soul of tomorrow's 24x7 data center.

By now, few would be shocked if I told you spinning media's days are over. Yes, Disk Is Dead as primary storage, and it is time to bring out your dead and dying disk arrays.

HIGHLIGHTS:

Hybrid Arrays no longer have any price advantage over Flash Storage Platforms.

HDDs are being replaced as the primary IT data storage medium.

A "clean sheet architecture" approach optimizes the inherent capabilities of flash and provides a complete solution with advanced data services.

Flash positions an IT organization well for future needs.





DISK IS STILL DEAD

by Steve Dalton, SVP, Engineering, Violin Memory



DEAD AND DYING TECHNOLOGIES

For a recent blog on the Violin Memory website, I wrote about two types of storage vendors who haven't been able to let disk rest in peace: The legacy vendors who gave up on innovation long ago and the appliance vendors who built single-tasking boxes for specific applications. We see these vendors opting to use flash behind dead interfaces and a dead disk form factor, and they call them SSDs.

DISK IS DEAD

For the last 60 years, disk technology delivered value to customers by increasing the areal density (amount of data stored in a given space) in each successive generation. In the last 5 years, that rate of areal density improvement has flattened. This means that long held expectation of ever-decreasing \$/GB from disks is no longer sustainable.

Though disk manufacturers continue to squeeze more bits on each square inch of rusted platter, they're doing so by sacrificing performance, thus further moving disk closer to the grave. While this is happening, the interfaces and protocols have improved very little, given the inherent limitations of the legacy HDD design.

SSD IS LIMITED

At the same time, SSD capacity, while increasing, has been constrained by the physical form factor of the HDD, thus limiting the storage density.

To illustrate, the table below shows the inherent inefficiency of putting NAND in the legacy disk form factor. The end results are bottlenecks to capacity and performance.

| Feature | Flash Storage Platform | Vendor A | Vendor B | Vendor C |
|-------------------------|------------------------|----------|----------|----------|
| Height (Rack Unit) | 3 | 3 | 5 | 5 |
| Raw Capacity (TB) | 70 | 40 | 48 | 40 |
| Effective Capacity (TB) | 217 | 120 | 173 | 202 |
| Performance (IOPS) | 1,000,000 | 150,000 | 375,000 | 150,000 |
| Latency (μ s) | 250 | <1,000 | <1,000 | <1,000 |

Table 1: Capacity and Performance

Vendors who clung to the HDD interface and form factor have less capacity, take up more rack space, and deliver less performance.

Violin Flash Storage Platforms deliver performance and enterprise-grade data services, including user selectable block-level, inline de-duplication and compression on a single, simple, powerful platform architected for zero downtime and zero data loss at end-user costs that compete with traditional disk array prices. The table below captures the efficiency and range of data services possible when design compromises like SSDs are avoided.

| Feature | Flash Storage Platform | Vendor A | Vendor B | Vendor C |
|----------------------------|------------------------|----------|----------|------------------------------|
| Continuous Data Protection | Yes | No | No | Additional Hardware Required |
| Stretch Cluster | Yes | No | No | Additional Hardware Required |
| Sync Replication | Yes | No | No | Additional Hardware Required |
| Granular Data Reduction | Yes | No | No | No |

Table 2: Data Services

To paraphrase my colleague Ebrahim Abbasi's recent essay, "Disk Is Dead and Now I'm Stuck with All of These Operational Expenses", it's interesting to consider the case of dumping your legacy storage infrastructure and going all flash. With higher storage density and high performance density, the benefit is near-instant savings in operating costs. Consider applying these savings to your own situation across your entire data center; now, what could you have done with all of that money?



YOU MUST BE KIDDING

by Cory Sindelar, CFO, Violin Memory



THEY ALL SAY “DISK IS DEAD”

At this point, analysts and opinion leaders in the media no longer argue whether disk is dead for primary storage: That’s a given. Now the debate is how quickly all-flash arrays will take over that role in a given enterprise.

As Violin’s CFO, I feel pretty good about disk being dead. I know some people are still clinging to their hard disk arrays or dead end, SSD-based storage. To me, as a CFO, that’s just bad business.

IDC WEIGHS IN

The recent IDC AFA White Paper says, flash “opens up the ability to implement new processes, generate additional revenues, and pursue new market opportunities not before possible”⁴. You can leverage a tectonic shift in storage technology and gain an advantage over the competition, reduce costs, improve processes and transform your business. Or you can just keep buying hard disk arrays.

SERIOUSLY?

If you have someone REALLY considering an upcoming storage technology refresh using hard disk arrays or SSD-based arrays, you have a right to feel angry. Very angry. At this point, neither option makes ANY financial or business sense.

I imagine you would be very angry to see IT waste money on old technology that simply cannot deliver on the needs of the business. That anger would pale in comparison to the frustration and disappointment you would feel if your IT team-mates considered yesterday's storage solutions for tomorrow's business needs and ended up missing an entire technology wave.

You can leverage a tectonic shift in storage technology and gain an advantage over the competition, reduce costs, improve processes and transform your business. Or you can just keep buying hard disk arrays.

If there is a truly disruptive technology wave that can change the economics of the data center, and give your business – or your competitors – a competitive advantage the way a Flash Storage Platform can, it seems obvious that your people should be bringing it forward to you for approval and implementation.

When changing technology presents an opportunity to fundamentally change the business, take advantage of it.

HIGHLIGHTS:

Press and analysts agree: Disk is Dead.

Missing a technology wave like flash can be fatal to your business.

Missing a technology wave like Flash is probably not good for your career, either.

4 *Why AFA Architecture Matters as Enterprises Pursue Dense Mixed Workload Consolidation*, ©2015 IDC #258074, sponsored by Violin Memory, written by Eric Burgener, Research Director for IDC's Storage Practice.





DISK IS DEAD AND IT'S TIME FOR YOU TO REALIZE OPEX RELIEF!

by Ebrahim Abassi, SVP Operations, Violin Memory



MISSING A TECHNOLOGY WAVE

In an earlier essay, I discussed the challenges of data center growth and the resultant growth of IT expenses, especially Operating Expense (OPEX) with power and cooling being the largest category of OPEX spending.

This can be a depressing reality for many Operations Executives. You will never get back all of the money you spent on operational expenses to keep things like legacy disk storage rotating (and rotating and rotating...). It would be very depressing to see IT waste money on old technology that simply cannot deliver on the current (and future) needs of your business. Fueling that depression would be the frustration and disappointment you would feel if your IT teammates considered yesterday's storage solutions for tomorrow's business needs and ended up missing an entire technology wave.

SOME PEOPLE JUST GET IT

So, don't be depressed. There is hope. I met recently with two customers who represent this hope. Each achieved an OPEX reduction in their storage infrastructure, and their compute resources with the acquisition of a new Flash Storage Platform from Violin.

The first customer is in the financial services vertical. They migrated a multi-threaded application to a Violin All Flash Array and improved job processing from 15 days to 1 day. The second is a lending company who consolidated 13 servers to 2 with the introduction of a Violin All Flash Array into their environment. This was made possible by the consistent sub-millisecond performance of Violin's Flash Storage Platforms: CPU utilization rates go up, and the need for extra, idle cores goes down – or away. These two customers not only achieved an OPEX reduction by not continuing to fill a rack (or racks) with hard disk drives, but were also able to save themselves the use of server resources (and eliminate applicable power and cooling load). In some cases where software is licensed per core, OPEX is reduced there, too. That doesn't sound very depressing to me.

We were also able to help these customers through our Professional Services offerings. We helped each with specific optimizations catered to their workload as well as migration services for moving the data onto their new Violin flash arrays.

IDC SAYS

Lastly, consider IDC's recent commentary⁵ on new flash-based architectures: "Flash deployed at scale brings much more to the table than just high performance, and many enterprises have found the impact of flash not only transformational to their IT infrastructures, but also to their business processes."

Disk is Dead and it's time to (finally) lower your OPEX – we can help.

This was made possible by the consistent sub-millisecond performance of Violin's Flash Storage Platforms: CPU utilization rates go up, and the need for extra, idle cores goes down – or away

HIGHLIGHTS:

A financial services customer reduced report run times from 15 days to one day.

Another customer consolidated 13 servers down to two by eliminating wait cycles caused by the I/O bottleneck.

IDC says "many enterprises have found the impact of flash not only transformational to their IT infrastructures, but also to their business processes."¹

⁵ *Why AFA Architecture Matters as Enterprises Pursue Dense Mixed Workload Consolidation*, ©2015 IDC #258074, sponsored by Violin Memory, written by Eric Burgener, Research Director for IDC's Storage Practice.



AFTERWORD: THE HARD DISK AUTOPSY

by George Crump, Lead Analyst, Storage Switzerland

The Violin Memory “Disk is Dead” campaign says what needed to be said; disk, at least for the production use case, is dead or it least it should be. An autopsy done on the technology will find that it died because it could not keep up with the performance demands of the modern data center and it could not use capacity effectively.

THE PERFORMANCE WALL

The performance of a hard disk is largely dependent on its rotational speed as well as the intelligence of the file system in how it orders data being written to that hard drive. In large part the only way to increase performance is to add additional hard disk drives. Even if there is no capacity justification to add those drives the performance imperative dictates that it the spindles be added. The result is wasted HDD capacity and data center resources like power, cooling, and floor space.

Flash storage fills the performance need left by the death of hard disk. Flash delivers performance in terms of raw IOPS and low latency, and a well-designed flash array can deliver that performance on far fewer and denser devices. For example, A 3U flash array from Violin Memory can deliver 500k+ IOPS, but a hard disk system configured to achieve that performance, would take thousands of drives while consuming almost the entire data center.

THE CAPACITY WALL

With the arrival of 8TB and 10TB HDD technology, it may seem odd to even suggest an HDD capacity wall. However, in production storage there certainly is. The capacity wall that HDDs face in production storage is that data efficiency like deduplication and compression techniques can't be used without adding flash to the HDD array. The lack of effectiveness means that 8TBs of data requires 8TBs of space.

Flash storage, however, can use its excess performance resources to leverage technologies like deduplication and compression to store more data in the same space. A 5:1 reduction ratio is considered a reasonable expectation for a data center using an all-flash array. Especially if that array is supporting a mixture of virtualized servers and desktops, unstructured data and database workloads. That means that same 8TBs of capacity may be able to store as much as 40TBs of data.

SSD – THE HARD DISK RESURRECTION?

As the role of hard disks changes to storing backup and archive data, solid state disks (SSD) appear to be the gateway drug to performance. They are in essence hard drives in a resurrected state. SSDs have the same form factor as hard disk drives, making it easy for vendors to deliver an all-flash

solution. Other than improved performance, SSDs carry many of the same challenges as HDDs.

SSDs, because of their need to fit into a hard disk bay, are typically physically larger than their flash module counterparts, a flash storage device that looks more like DRAM. The wasted space, caused by retrofitting flash into a hard disk slot, leads to wasted data center floor space. Also, since SSD often go into the same chassis as an HDD, the chassis is designed to power HDD, not memory. As a result, there is often little power savings.

The future of flash is an approach that looks nothing like a hard disk drive. Instead it will leverage a more modern form-factor and interface that allows densely packing these flash into purpose-built storage systems. A purpose built design eliminates the other SSD challenge; achieving optimal performance while increasing density and decreasing power consumption.

High performance is an end-to-end problem. Every component from the interface that connects the flash array to the storage network to the internals of the flash array to the flash NAND itself has to be tuned to work together. Often, storage systems are HDD arrays retro-fitted with SSDs and see very few other changes. Certainly performance improves compared to an all HDD system but it is not an optimal use of flash.

CONCLUSION

It is reasonable to expect in a few years that we will be declaring "The SSD is Dead". It has served as a viable gateway to flash storage specific future. Despite all the hype around software-defined "everything", a silicon-driven world will likely be powered by hardware that is purpose-built to take advantage of the low latency and high performance of flash.

DISK IS DEAD

& NO SSDs

APPENDIX A: ADDITIONAL RESOURCES

ESG White Paper:
The Economic Impact and Value
of Violin's Flash Storage Platform

[www.violin-memory.com/
ESG-Economic-Impact-and-Value-of-Violin](http://www.violin-memory.com/ESG-Economic-Impact-and-Value-of-Violin)

The TCO Benefits of Flash
are "Just Too Compelling" —
Details from IDC

[www.violin-memory.com/
IDC-Why-AFA-Architecture-Matters](http://www.violin-memory.com/IDC-Why-AFA-Architecture-Matters)

Disk-Based Storage is
on the Defensive —
Details from The Mesabi Group

[www.violin-memory.com/
Mesabi-Group-on-Violin-Memory](http://www.violin-memory.com/Mesabi-Group-on-Violin-Memory)

ESG Video:
Disk is Dead. Keep on Truckin',
Not Keep on Spinning

[https://www.youtube.com/
watch?v=6ogpOKF1Usw](https://www.youtube.com/watch?v=6ogpOKF1Usw)

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www.violin-memory.com/diskisdead