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FINDING A HOME FOR FLASH

Flash SSD comes in a variety of form factors, but where's the best place to put it for maximum effect in virtualised environments?

TechTarget

Commoditisation trend poised to change storage landscape dramatically

Vendor consolidation is a fact of economic life since the bigger a company is, the more it can push economies of scale. The cloud is threatening to accelerate this consolidation significantly.

ATE LAST YEAR I pondered how storage might look in five years' time. I looked at the effects of server and desktop virtualisation on storage, noting that the needs of virtualisation had given shared storage a leg-up to near ubiquity among organisations but also that its shortcomings threatened to see it eclipsed by forms of storage that brought server and storage (with tiers, including flash) much closer together.

While that was an attempt at assessing the trends—existing and nascent—in storage technology, it's arguable that it is an incomplete one. It was an "internal" view, if you like, and one that failed to take account of the wider forces, mainly economic, that will shape our industry. So, here I'd like to look at storage in a much wider landscape.

The big theme I want to examine here, the one I see as potentially shaping the future of storage, is concentration of ownership, of vendor consolidation. It's a fact of economic life. As capitalism in general and as industries within it have arisen and matured, the ownership of enterprises has followed a familiar pattern that sees a proliferation of businesses that then tends towards an ever-smaller circle of ownership until a few big players are left.

We've seen it in all the major industries. Whereas in the 19th century every busy town with thriving industries had numerous local banks, now each country has a few that dominate, and many are global in reach. Whereas initially individual men with a well and some draught animals drew oil from the ground and moved it to town, now the international oil industry is dominated by fewer than 10 companies. Whereas at the start of the automotive industry every major town had a blacksmith putting motor vehicles together for local customers, we now have a small number of multinational car makers.

We've seen it in storage too. Go and look at the Wikipedia page on "defunct hard disk manufacturers" and you'll see a list of almost 100 companies that have tried their hand and failed, and either gone bust or been absorbed by the five that now rule the market.

This concentration of ownership is a fact of economic life because the bigger a firm is, the more it can make economies of scale and push down supply costs and wield power generally in the marketplace. It's also true that bigger businesses can generally weather bad times better than small ones, and for this reason every economic recession since capitalism began has seen accelerated waves of industrial consolidation.

When it comes to the storage systems market, we also have concentration, although the character of the industry is distinct from others. We have some very large storage vendors that take the lion's share of the market. The "big five" includes HP, EMC, NetApp, IBM and Dell. But, that said, there are a myriad of smaller players, ranging from those just outside the big five, such as HDS, Oracle and Fujitsu, through to the micro-vendors and startups.

Oil is a commodity, but IT and storage are not. Will that always be the case? Not necessarily, and the cloud could force this change.

In storage the ecosystem of established giant vendors and (usually) innovative startups seems to exist in a state of dynamic stability. The big players scrap over percentage points of market share, while the startups innovate and ultimately gain the attention of the big boys, at which point they are often bought by them and folded into the larger companies' efforts to win market share.

Corporate IT systems are complex and extremely technical. They are vast and made of many parts from many vendors, as storage systems within them often are too. This makes storage unlike, for example, the oil industry. In the latter, there's no scope for someone coming up with a new type of oil that some people might decide will help their cars run better. The big oil players dominate from exploration through transport and refining to sales, so there's just no way in for an oil company startup. The customer simply gets the type of oil product they need. Despite buying it from one oil company, they probably don't know who pumped and refined it, and they don't need to.

In short, oil is a commodity, but IT and storage are not. Will that always be the case? Not necessarily, and cloud could force this change. Right now we're used to an environment in which the IT vendor delivers the end product, ie, the storage or the IT provision. If the cloud takes off, processing and storage could become a service, delivered to the customer from giant remote processing and disk farms. It is surely only a matter of time

before bandwidth and security are up to the task.

When that day arrives immense shock waves will go through the vendor community, as suggested by Chris Mellor in this recent column for SearchStorage.co.UK. Effectively, what would happen—framing this in terms of consolidation and commoditisation—is that much of the IT vendor community would no longer sell directly to the customer organisation. Instead, the cloud provider sector would become the predominant buyer of IT and storage products. Such a sector, arising anew, would become highly standardised, buying huge amounts of equipment that would allow it to deliver processing and storage to end users just like pumping gas.

In such a world, consolidation among big IT and storage vendors is only likely to increase. No longer would there be a populous user customer community and appetite for point products among customer organisations. The provision of IT will have moved upstream. It's true that the oil industry has its share of small, often innovative consultancy, outsourcing and specialised technical businesses, but the end user never sees them. This would likely be the case too in a cloud-based IT world. As the big vendors dominated sales into huge cloud providers, the ecosystem of startups and specialists would thin out to those able to coexist in the new environment.

All of which throws up the question: What kind of storage market would such a scenario demand? It's all very well to extrapolate on the likely direction of storage technology from today's economic realities. But those are not tomorrow's. We may look back on these last couple of decades in IT like we look back at the age when blacksmiths built the first cars or mule trains carried barrels of raw crude from the Pennsylvania hills. ■

Antony Adshead *is bureau chief for SearchStorage.co.UK.*

Enterprise flash:

3 implementation options for virtualisation

Enterprise flash now comes in a variety of form factors aimed at speeding I/O beyond what's possible with spinning disk in server and desktop virtualisation scenarios.

BY MANEK DUBASH

NTERPRISE FLASH STORAGE is being bought in increasing numbers, and new enterprise flash products are emerging from vendors old and new to meet that demand.

The key drivers in the enterprise flash market are a combination of the falling cost of flash memory, which is making solid-state storage an increasingly economic proposition, and lagging spinning disk performance, which has become the bottleneck in many data centres.

That bottleneck is largely a result of the demands of server and desktop virtualisation, which can generate large volumes of random I/O from a single host. In addition, some database tasks can provide similar challenges, requiring large volumes of throughput.

Spinning disk struggles to cope with such demands, to which the solution was often to add more disk. This increases throughput, especially if you short-stroke drives. But this also increases heat levels and power consumption and means buying much more capacity than you actually need to satisfy throughput requirements.

Enterprise flash technology ameliorates the problem by providing hundreds of times more bandwidth than mechanical devices—the exact boost depends on the technologies involved—and by reducing latency for time-sensitive workloads. Flash drives' lower capacity vs mechanical disks is a minor issue compared with the bandwidth advantages they offer. Their higher prices are their main drawback but, in a growing range of circumstances, they are the only viable option.

THREE WAYS TO IMPLEMENT ENTERPRISE FLASH

Broadly speaking, you can implement enterprise flash technology in three ways, with your selection depending on factors such as cost and application.

Server-based flash sits closest to the processor and so offers the lowest latency with zero overhead from network or storage interfaces. It is usually implemented in the form of a PCIe card; vendors include EMC, Fusion-io, OCZ, Micron and LSI. While it delivers the best performance, some argue that this implementation has all the disadvantages of direct-attached storage without the flexibility.

Next on the performance chart is an all-flash appliance or array, connected conventionally via NFS, CIFS, Fibre Channel or iSCSI. Products from Texas Memory Instruments, WhipTail and Violin Memory fall into this category. While still providing considerably better performance than spinning disk, they use familiar interfaces and can offer more enterprise-level features, such as redundancy and hot-swapping.

Finally, there is the addition of flash as a tier to "traditional" arrays. This was a move pioneered by EMC in 2008, and now pretty much all SAN and NAS vendors allow for the addition of solid-state to their products.

There are also vendors that have designed arrays especially to mix the two, such as Nimble, which aims to exploit the best cost/performance characteristics of spinning and solid-state drives, using flash for high-performance data while high-capacity, low-cost SATA drives provide the main storage and backup capacity.

Let's take a look at a few UK IT organisations that have implemented enterprise flash storage.

IN-SERVER FLASH MAKES KONTERA'S WEB ANALYSIS FLY

Kontera delivers real-time, Web-based, content-relevant advertising from offices in the US, UK and Israel. Its 300 physical servers contain about 1,000 virtual servers, and it uses a 360 GB MongoDB database to analyse the 100 million daily page views generated by its 15,000 publisher clients, and then insert ads relevant to page content. The aim is zero delay in the delivery of Web pages.

"We can analyse what the page is all about and serve ads according to what people who access this type of content typically read," said Ammiel Kamon, executive vice president of marketing.

The task is a mammoth one. "We have around 300 servers providing input and getting results from the core analysis cluster in real time. This translates to hundreds of gigs of data being written and read per hour as small discrete transactions. This then translates to 20,000 IOPS with each transaction requiring a sub-10-millisecond response time," Greg Pendler, production operations manager, said.

The company designed and implemented a model that it believed would deliver the volumes of data required, consisting of four main servers containing the database, and a range of distributed servers. The main servers run MongoDB on CentOS and consist of 2.2GHz 2U machines, each with 72 GB of RAM plus a 640 GB Fusion-io ioDrive. These central servers are linked to the remaining, distributed servers, whose task is to analyse the data.

"Compared with physical drives, we obtained 50 to 100 times better throughput [with Fusion-io's ioDrives]."

—GREG PENDLER production operations manager, Kontera

"There's one main server that receives data and three others that it's replicated to," Pendler said. "The storage was always going to be direct-attached, as the old model of NAS and SAN didn't work for us because we couldn't scale it horizontally. When we tried NAS, it killed the network."

Kontera tried spinning disks but was unable to attain the throughput required. "We tried installing six [15,000 rpm] drives per server, but writes were taking a couple of seconds," Pendler said. "Sixteen might have done the job, but the size and price of the server were a problem."

The company then tried implementing in-server, PCIe-attached flash memory products from OCZ but found the hardware to be unreliable, with a 50 percent failure rate in the first 90 days. "We tried a cheap solution with OCZ, but it didn't work," Pendler said.

So Kontera replaced the OCZ products with Fusion-io ioDrives and has since experienced no reliability issues.

"Compared with physical drives, we obtained 50 to 100 times better throughput," Pendler said. "Flash-based storage will also work out cheaper than spinning disks in the long term, and this was a factor in our decision to go with Fusion-io. Having multiple spinning disks eating power and generating heat is not a good idea."

Implementation of the ioDrives went smoothly, according to Pendler, with each server being upgraded one by one, and the data replicated over once it was up and running.

And would Pendler do the same thing again? “We know where to go first next time,” he said.

THE PENSIONS TRUST OPTS FOR AN ALL-FLASH APPLIANCE

The Pensions Trust (TPT) is a provider of pensions fund services for not-for-profit organisations from three offices in the UK. Using an all-VMware infrastructure based on VMware View, the IT department commands about 3 TB of storage in its SAN to support about 200 desktops, about 90 percent of which are running Windows XP, while the rest run Windows 7. It recently bought an all-flash WhipTail Technologies Virtual Desktop XLR8r appliance to support its VDI operations.

Darren Bull, business support manager, said TPT decided to implement virtual desktops because of the wide disparity of configurations on the organisation’s physical desktop PCs and the resulting high support load, which stretched IT resources. “The PCs were all in a different state, and we had problems supporting that, so it made sense to centralise and make it easier to troubleshoot,” he said.

This led to problems with performance, with users complaining that pilot virtual desktops were slow to respond. Bull said spinning disks were struggling to deliver the I/O loads that virtual desktop infrastructure (VDI) places on storage. Bull said that he could foresee even bigger problems ahead when TPT undertakes its migration to Windows 7, as is planned later in 2012, as Windows 7’s I/O demands are higher than those of XP.

"We like [Nimble's] ability to create volumes with a block size that matches the application. This makes replication from one SAN to another very efficient."

—SIMON HEYES managing director, Xicon

“We calculated how many more spinning disks we would need to meet VDI’s I/O requirements and could see that it would cost a lot of money,” Bull said. “So we looked at Atlantis Computing’s ILIO [virtual appliance], which would have meant we could carry on using traditional disks at the back end. However, the cost of added Atlantis and VMware licences and the risks created by the complexity of plugging something else in the middle that could go wrong made this solution less attractive.

“We also considered NetApp Flash Cache, but that means buying new storage controllers, which we found would cost too much and result in too much disruption of our existing infrastructure,” he said.

"We found WhipTail's website by chance using Google, we got an evaluation unit and straight away we knew it was the right decision. It was fast, simple, and it worked. I wasn't aware of any other unit available for virtual desktops, and while people said we were brave, it has gone well. It has been very reliable and has reduced issues and support for desktops."

The key benefit is clearly performance, according to Bull, and since the company does not run a large server room, any savings from reduced power and cooling are not significant. Bull also found that users appreciated the new infrastructure. "We surveyed users who said their virtual desktops were faster than their old physical PCs, and that's what the WhipTail delivered, so I consider it money well spent. It does exactly what it said it would do."

Bull said that the XLR8r could be improved upon but appreciates that WhipTail is a small, evolving company. "The management interface is a bit clunky and limited, but they do have plug-ins for vSphere coming up, and this box fits our environment from a size point of view. Also, we would like to enable deduplication, but this reduces throughput massively. However, the company says that it is developing a new deduping engine that will run at near-line speed."

Bull expressed concern that the XLR8r represented single point of failure but said that WhipTail provides next-day replacement. "A redundant unit would be quite a big investment for us, so we will try and use our primary SAN as a lifeboat for the desktops. It's a cleverer way of doing it, even if it won't perform as well for the time it takes for a replacement to arrive."

In summary, though, Bull remains positive about the all-SSD storage: "It was a lot of money for a 1U box, but we're getting the kind of I/O that we would not get from a rack of disks. What's more, once the deduping is upgraded we might be able to fit some servers on to it."

XICON SELECTS NIMBLE HYBRID HDD/SSD ARRAY

Cheshire-based Xicon specialises in providing cloud services for UK-based SMEs, including hosted desktops, applications such as Microsoft Exchange and database servers. The company has just incorporated into its virtualised cloud infrastructure a replicated pair of Nimble Storage CS220 hybrid HDD/SSD arrays with a total usable capacity of 16 TB each, and a flash capacity of 640 GB.

Xicon's projections showed that with growing demand for desktop virtualisation and database server access, both heavily dependent on I/O performance, it would run out of IOPS over the following six months. "Our challenge was to find an infrastructure that could satisfy large customers and small, with five or 1,500 users," managing director Simon Heyes said.

"We currently use about 30 TB of storage from EMC and Dell EqualLogic," he said. "We have never had a problem with them, but for the next step

in performance, we would either have to buy a lot of very fast spinning disks or SSDs.

"The load varies in terms of database transactions, and desktop applications are very time-sensitive with close to zero latency required. For example, if you're typing into a virtual desktop, delays make it very annoying and unusable."

Spinning disk technology alone would not be able to deliver the performance that Xicon's mixed workload demands, especially virtual desktops.

"When you read IOPS ratings, you can calculate that with hosted desktops you need between 10 IOPS to 30 IOPS per desktop, so 100 users need 3,000 IOPS, which is the performance of a fast array with fast drives. With 500 or 1,500 users, you need tons of those arrays. Effectively, you're up against the limitations of spinning disks and the laws of physics, and disks also cost a lot of money to run, generate heat and use power. It gets to the point where you think there must a better way," Heyes said.

So when Heyes looked for an alternative, he found the Nimble appliances, which combine SSDs with mechanical storage.

"Their claims of a combined appliance for backup and primary storage intrigued me because I thought it was a bad idea. However, it got my interest, as did Nimble's performance claims," Heyes said. "The way they used flash sounded feasible and proved itself to be so."

"Lots of storage vendors have used flash as an accelerator, but Nimble said they were doing something different: using high-capacity SATA drives to deliver high performance and capacity. They said they could deliver high performance with a fraction of the number of disks, which is important for a cloud provider because it occupies less floor space and uses less power."

Heyes obtained an evaluation unit and tested it. "I don't impose a new technology on my engineers just because it's cheap; it has to measure up. Our techies were well impressed."

Heyes also liked the Nimble units' storage and bandwidth efficiency. "We like the ability to create volumes with a block size that matches the application. This makes replication from one SAN to another very efficient because you don't waste a lot of bandwidth replicating empty space."

Overall, for Heyes the Nimble appliances' key benefits were hardware costs, efficient space usage, and power and bandwidth savings. He also liked the design and was impressed by Nimble's founders' heritage: "They worked at Data Domain, and we were impressed with that gear, so we thought Nimble will know what they're doing, what works and what doesn't."

The units, once installed, were up and running inside 30 minutes with no technical challenges or even a need to consult the manual. ■

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STATUS REPORT:

Solid-state storage

Solid-state storage has carved out a niche in the storage ecosystem, establishing itself as a viable alternative for high-performance applications.

BY PHIL GOODWIN

SOLID-STATE DISK is, of course, nothing of the sort. Whereas a disk is a round, flat object, solid-state storage is really just memory chips. That may seem like a silly semantic distinction, but it's actually important to bear that in mind when architecting a data access solution. Solid-state drives (SSDs), also referred to as flash memory and flash cache, have more in common with memory—specifically cache memory—than with spinning hard disk drives (HDDs). Although SSDs are commonly deployed "behind the storage area network (SAN)" and provisioned as part of the total storage pool, they behave like large repositories of cache. That's important to consider when designing solid-state storage into a storage solution.

SSD CHIP TECHNOLOGIES

Three solid-state storage technologies dominate the market today: single-level cell (SLC), multi-level cell (MLC) and enterprise multi-level cell (eMLC). This may seem like an splitting hairs, but you'll need to understand the different SSD technologies (just as you do with HDD technologies) to make the appropriate deployment choice.

MLC is currently the most prevalent consumer-grade solid-state storage, whereas most enterprise-class products are built around SLC. MLC

offers a significantly lower price point on a per-gigabyte basis but also has a significantly lower useful life. Individual SLC memory cells can sustain approximately 100,000 write operations before failure, but MLC cells are only good for about 3,000 to 10,000 write operations before they fail. Cell failure can be one cause of SSD performance degradation and may be the reason a solid-state device gradually becomes unacceptable over time. Obviously, MLC devices will retain their capacity and performance only about one-tenth as long as SLC for a given write workload. It's therefore important to ask the vendor to describe the "use profile" for its product and to factor it into the cost-per-unit equation. A product that looks like an irresistible deal at half the price of other systems is no bargain if its useful life is just a small fraction of the higher-priced product.

A product that looks like an irresistible deal at half the price of other systems is no bargain if its useful life is just a small fraction of the higher-priced product.

Enterprise MLC is a newer technology gaining traction in the industry. With an estimated life of 20,000 to 30,000 write cycles, eMLC reaches a middle ground both in price and life span between SLC and MLC. Nimbus Data Systems has committed to eMLC technology, using it in all its data storage products while other vendors are still using SLC. To avoid write-related life span and degradation issues, Nimbus' controller software has "wear-leveling" capabilities and aligns write blocks with flash cells. Nimbus also offers a five-year warranty for those concerned with product longevity.

SERVER-BASED SOLID-STATE STORAGE

Another emerging technology trend is towards host-based solid-state storage delivered as PCI Express (PCIe) cards for insertion directly into the host. Fusion-io, LSI, Texas Memory Systems and Viking Modular Solutions all offer PCIe solid-state products. Although provisioned like storage, host-based solutions behave very much like cache. Being "in front" of the SAN has the advantage of avoiding network latency for read operations, yet data can be pre-positioned using automated storage tiering (AST) technologies, depending upon the array vendor's capabilities. On the flipside, it's subject to host failure so storage managers should ensure the PCIe solid-state storage is properly data protected through RAID, mirroring or clustering.

EMC is joining the fray and has announced its VFCache, which is its first PCIe host-based storage product. This product is fully accessible using EMC's Fully Automated Storage Tiering (FAST) software so that it works

seamlessly with EMC's arrays across the SAN. The initial product will be based on SLC technology to maximise the longevity, performance and reliability of the device.

SOFTWARE IS KEY TO PERFORMANCE, LONGEVITY

Most solid-state storage vendors would agree that software is critical to the performance of their storage devices. LSI offers its MegaRAID CacheCade 2.0 software, designed to optimise both reads and writes by managing writes to specific blocks. CacheCade complements LSI's MegaRAID SSD controller cards for use with SSD devices or arrays.

Hewlett-Packard (HP) similarly points to its data location algorithm for optimising solid-state performance in its 3PAR arrays. The company touts

Solid-state storage use cases

Database acceleration	Loading the database indexes or even the entire database into SSD or optimally host-based flash memory can significantly improve data access speeds.
Cache tier	Adding SSD as a cache tier can accelerate data access to the most frequently requested information, very much like any other cache.
Boot storms	Loading VDI images into solid-state storage can solve the problem of "boot storms" during periods of high user startup.
Data location and hybrid cloud	Locating frequently requested data in cache storage near the requestor can speed data access and reduce the load on central SANs.
All solid-state infrastructure	For applications with high-intensity I/O requirements, solid-state infrastructure can meet the needs of and reduce power/cooling consumption by up to 80% compared to similar 15,000 rpm hard disk drive configurations.

this optimisation algorithm for its ability to avoid the gradual performance degradation that may occur otherwise. Other vendors, such as Avere Systems and NetApp use non-volatile random access memory (NVRAM) to buffer and manage write operations, all of which is managed by their own proprietary software to find the appropriate write path.

IO Turbine, which was recently acquired by Fusion-io, developed Accelio, software that allows SSDs to be provisioned across VMware virtual machines (VMs). The VMs can use Accelio to share SSD or other flash storage. Accelio can be used with virtually any SSD/flash product and supports VMware vMotion functionality.

USE CASES FOR SOLID-STATE STORAGE

■ **Database performance enhancement.** Most storage managers recognise that SSD offers blazingly fast read operations, making it ideal for database environments with read-intensive applications. In this scenario, the database indexes are typically loaded into SSD or flash storage for quick lookups followed by accessing the HDDs to fetch the actual data. However, with the increasing size and affordability of solid-state storage devices, some organisations are finding it possible to load an entire database into the SSD, which significantly speeds up all database functions.

Jackson Rancheria Casino & Hotel in California has been testing database performance with a combination of Dell EqualLogic arrays, Fusion-io PCIe-based solid-state storage and IO Turbine's Accelio software. (Jackson Rancheria is a beta test site for Accelio.) The casino has a 300 GB Microsoft SQL Server database supporting its gaming operations, which is a read-intensive app. Approximately 80% of the servers are virtualised using VMware ESX.

Shane Liptrap, senior systems engineer at Jackson Rancheria Casino & Hotel, reports excellent test results. "Initial setup of the Accelio software only took about an hour and was similar to creating VMware resource pools," he said. "We saw a definite improvement in performance. Using Accelio with a 150 GB Fusion-io SSD, our read latency dropped 60%. Using a 320 GB Fusion-io flash card, it dropped 90%." This configuration took the load off the SAN and Liptrap expects to see better reliability and failover in addition to better response time as the configuration is moved into production.

■ **Cache tier.** Several vendors are increasingly adding solid-state storage to their arrays as a "cache tier." Although this is also referred to as tier 0, the lines between a distinct storage tier and cache are increasingly blurred. NetApp, in particular, is taking this approach, with the added twist of applying data deduplication to its Flash Cache. NetApp claims deduplication can improve capacity utilisation by up to 10-to-1. VM images in Flash

Cache can be improved by 3-to-1 or 4-to-1. Adding deduplication instantly improves the economics of adding Flash Cache to a configuration.

HP's 3PAR arrays use adaptive optimisation to seamlessly blend the SSD and Fibre Channel (FC) HDD tiers in the array. Datapipe, a managed services vendor in New Jersey, uses 3PAR arrays to handle the requirements of a

Solid-state defined

ACRONYM	DEFINITION	WHY IT'S IMPORTANT TO KNOW
SSD	Solid-state drive (or disk)	SSD is typically used to refer to solid-state storage that's packaged in a hard-disk form factor.
SLC	Single-level cell	This is a type of flash that stores a single bit in each chip cell; it's the fastest, most reliable, longest-lasting and most expensive type of NAND flash.
MLC	Multi-level cell	This is a NAND flash chip that stores two bits per cell; it's slower and doesn't last as long as SLC, but it's cheaper.
eMLC	Enterprise multi-level cell	eMLC is a "souped-up" version of MLC flash with a controller and software that remedies some of the shortcomings of MLC; it's becoming more popular in enterprise solid-state products.
PCIe	PCI Express	PCIe is a high-speed server bus technology that's used by a number of server-based solid-state storage products.
NVRAM	Non-volatile random access memory	This is high-speed memory that's extremely fast like DRAM but can retain data when the power is turned off; it's used as a cache in some flash solid-state storage systems.

diverse set of customers. Datapipe offers SSD as a value-added option to customers who need additional I/O performance. “SSD isn’t cheap, so you really need to get a bang for the buck,” said Sanford Coker, Datapipe’s director of storage administration. He recommends host-based flash memory when possible. In many cases, Coker will deploy SSD for database applications to support a wide variety of industries, from financial and pharmaceutical to new media and cloud. SSD is indispensible to him when a guaranteed I/O level is required.

Dataram, a 44-year-old firm best known for RAM products, is one of the companies promoting cache tiering with its XcelaSAN appliance. One use case for this cache tiering device is adding I/O capacity to existing configurations. By adding a small amount of SSD, Dataram believes customers can avoid more costly upgrades to tier 1 and tier 2 arrays. Moreover, it claims to be able to deliver the same aggregate I/O and capacity of FC storage with a cheaper combination of SSD and SATA devices.

■ **Boot storms.** An excellent app for networked storage is virtual desktop infrastructure (VDI) support. VDI causes “boot storms” during periods of high user system startup, and because that activity is a purely read application, it’s ideal for the extreme I/O performance of SSD. Deduplication, as in the case of NetApp, reduces the cost of solving this problem.

■ **Data location and hybrid cloud.** Solid-state technology can also be used to position data closer to the user to reduce data access latency caused by distance. This will usually involve an SSD appliance rather than a PCIe card or just another tier. The Demand-Driven Storage architecture on Avere Systems’ FXT SSD arrays is an example of such an implementation. FXT arrays can be used with a centralised data centre setting, private cloud or hybrid cloud. These arrays can be clustered to provide high availability with Avere’s tiered file system to ensure data consistency.

Automated tiering software can automatically move data between tiers, even over a wide area network (WAN), so the most frequently accessed data is moved to the location or locations where it’s in high demand.

One application that fits well into this use case is on-demand video streaming. Datapipe supports these types of applications for some of its customers. “When a new video comes out, it gets a lot of hits. By elevating these videos to a solid-state tier, we can handle a lot more data requests in a shorter time span resulting in better user experiences,” Datapipe’s Coker said.

■ **All solid-state storage.** Not many people consider an all-solid-state infrastructure, assuming the cost would be prohibitive. Nimbus Data Systems hopes to change that perception. Nimbus designs its own eMLC flash memory units and offers them with the aforementioned five-year

warranty. However, to make an all-solid-state product comparable to those offered by more established array vendors, you need the accompanying software to support the platform. Nimbus includes the storage operating system, RAID, deduplication, snapshots, thin provisioning, replication and mirroring. Nimbus claims its systems require up to 80% less power, cooling and rack space compared with a 15,000 rpm HDD system. An all-solid-state storage infrastructure may not replace high-capacity HDDs for nearline or archive storage, but it may be the right choice for I/O-intensive applications.

HARD DRIVES STRUGGLE TO KEEP PACE

Hard drive technology over the past several years has seen significant advances in areal density, continuing the ever-falling per-gigabyte cost curve. But hard disk drive I/O throughput hasn't kept up with the much faster servers and networks over the same period of time. Applications are becoming increasingly I/O bound as the demand for data access increases. In some cases, storage managers must deploy extra, unneeded capacity to get the aggregate I/O throughput required to meet the application's demands. This unused capacity dramatically alters the economics of high-capacity drives.

Nevertheless, solid-state is no panacea. "Solid-state offers a lot of advantages, but it's not always the solution," Datapipe's Coker advises. "There's still no substitute for good system design. Application owners need to be prepared to work with their storage provider to properly tune and provision the right combination of SSD and HDD. Moreover, we've found that SSDs tend to get slower over time. You can work to manage them and reformat them, but at some point you have to be prepared to just replace them. It's different from managing HDDs."

Solid-state storage, though more expensive than HDDs on a per-gigabyte basis, may be substantially cheaper on a per-I/O basis. IT managers should consider the cost per I/O in their economic analysis. Add this to the lower power and cooling requirements, and the TCO will likely make sense for application acceleration. IT managers shouldn't expect SSD to follow the HDD cost curve. It's fundamentally a memory product, so it will follow the memory cost curve. As eMLC advances technologically, it may make solid-state even more attractive and broaden its applicability in the data centre and cloud. ■

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Cloud backup

is ready for the enterprise

Cloud backup services have seen increased adoption by SMBs, but with a choice of methods and tighter controls, cloud backup is now also a viable enterprise alternative.

BY JACOB GSOEDL

BACKUP WAS ONE of the first services offered by cloud storage vendors, and it's still the most popular way of using cloud storage. Once considered an option for only smaller companies, some enterprises are now using cloud backup for remote office and desktop/laptop data protection, archival, and off-siting of backups to supplement existing in-house backup services.

The benefits of backing up to the cloud are compelling: no need for backup infrastructure, minimal IT resource requirements and usage-based pricing that becomes part of your monthly operational expenses. But the benefits are offset by security concerns and restore challenges, especially if a lot of data must be restored from the cloud. With accelerated adoption of cloud services, cloud-based backup options have substantially increased, giving companies several alternatives:

- Backup managed service providers (MSPs)
- Cloud-enabled backup applications
- Cloud gateways

CLOUD CONSIDERATIONS

Regardless of the alternative your company opts for, this list of key features and considerations will help determine the right product for your environment.

Security. Security is still the main reason companies steer clear of cloud services. To address security concerns, cloud backup products must adhere to the minimum following best practices:

- Data must be encrypted during transit, usually via a Secure Sockets Layer (SSL) connection if the Internet is the transport.
- Data must be stored encrypted in the cloud via a state-of-the-art encryption protocol, such as 256-bit Advanced Encryption Standard (AES) encryption.
- The cloud service provider must support strong, enforceable authentication with features like password expiration and complexity.

Encryption key management must be clearly understood; most cloud service providers defer key management to users with the benefit that encryption keys are unavailable within the cloud. But with encryption key management the responsibility of users, the cloud service provider won't be able to help if the keys are mismanaged or lost, preventing access to the data. Because encryption keys are critical, some companies put them in an escrow account as protection against loss or corruption.

Compliance. There may also be compliance issues related to using cloud backup. For public companies or industries that are subject to additional regulatory requirements, only cloud service providers that adhere to SSAE 16/SOC 1 (formerly known as SAS 70) should be considered. SAS 70/SSAE 16 is an audit standard for service providers where an external auditor evaluates controls and processes, and prepares a report that's shared with the service provider's customers. Because there's a Type I and Type II SAS 70/SSAE 16 examination, it's crucial to confirm that the service provider performs the more stringent Type II audit. Only a Type II audit report expresses the auditor's opinion on whether the controls tested operated effectively enough to provide reasonable assurance that the control objectives were achieved during the period specified. For instance, Sarbanes-Oxley (SOX) audits usually only rely on Type II audit reports.

You should also understand the scope of the audit report and what it covers. Many smaller MSPs are quick to declare SAS 70/SSAE 16 compliance by providing data centre or Amazon (if the MSP uses Amazon on the back end) SAS 70/SSAE 16 reports, which usually aren't sufficient. While a data centre SAS 70/SSAE 16 report addresses physical controls, it has no bearing on operational controls of the MSP in relation to change management, programme development and access grants. Therefore, it's highly recommended to request the latest SAS 70/SSAE 16 report from the cloud service provider prior to signing with the service, and to have the report reviewed by the internal and external auditors.

Hybrid vs pure cloud backups. In a pure cloud backup scenario, agents on protected servers and desktops perform backups directly to the cloud. Quick setup and minimal maintenance are benefits of this service. A pure cloud backup product is best-suited for personal backups and backups for smaller firms with limited amounts of data to protect (typically a few terabytes). The drawbacks of backing up directly into the cloud are performance and bandwidth challenges because of latency and bandwidth limits of available Internet connections; these shortcomings are most important when restoring data.

Cloud backup options: Pros and cons

OPTIONS	PROS	CONS
Managed service provider (MSP)	■ Simplicity ■ Cost-effective ■ Few on-premises IT resource requirements	■ Complete dependency on the MSP for all aspects of the backup ■ Control is handed off to the MSP
Cloud-enabled backup apps	■ Extends and supplements existing backup infrastructure and processes ■ Except for backup data location, control remains with the customer ■ Cost-effective	■ Requires a cloud-enabled backup application ■ Little impact on IT resource requirements
Cloud gateways	■ Works with any backup application that supports backup to disks ■ Extends and supplements existing backup infrastructure and processes ■ Except for backup data location, control remains with the customer	■ Introduction of an additional IT infrastructure component that needs to be managed ■ Higher cost

Latency and limited bandwidth are mitigated by hybrid cloud backup products that use an on-premises disk or gateway as the initial backup target from which the data is replicated to the cloud. The on-premises intermediary usually caches the most recent backups for on-premises restores, minimising tedious recoveries from the cloud; it also moves data into the cloud asynchronously. For a pure cloud backup solution without the on-premises intermediary for quick restores, it's essential to understand all restore options, including the ability to have backups shipped to you on a disk or NAS device; restore options become more relevant as the amount of data stored in the cloud grows. Similarly, some MSPs accept the initial full backup on an external storage device (known as "seeding") to avoid a time-consuming first backup over the Internet.

Efficiency. Backup processes that are OK for on-premises backups may be unacceptable for cloud backups. For instance, the ability to perform subfile backups of changes to files is an indispensable feature in a cloud backup product. With email personal folder files (.PST files) that can grow beyond gigabytes, and large Excel spreadsheets and PowerPoint presentations spanning tens of megabytes, being able to only back up file changes to the cloud rather than complete files is a non-negotiable feature for a cloud backup product. Similarly, the ability to perform continuous incremental backups minimises the amount of traffic for each backup. The traditional weekly full and daily incremental backup discipline frequently used for on-premises backups doesn't work for backing up data into the cloud. Limited network bandwidth makes efficiency one of the primary virtues in a cloud backup product. So anything that can help reduce the amount of data to be moved into the cloud is critical.

Compression and source-side deduplication are two technologies that help minimise the amount of traffic sent into the cloud. Data deduplication reduces bandwidth usage and also helps cut the cost of backing up to the cloud. Because cloud storage pricing is usually based on gigabytes stored, compression and dedupe are instrumental in lowering monthly fees. To maximise data reduction, some MSPs deduplicate on the source side and one more time in the cloud. While the scope of source-side dedupe may be limited to a single or few hosts, dedupe in the cloud can be performed against all data, resulting in significant additional data reduction.

"We deduplicate and compress before we send data across, and we deduplicate one more time once data is in the cloud," said Karen Jaworski, senior director of product marketing at Evault, a Seagate company and backup MSP.

Transport. Besides source-side dedupe, cloud backup products differ in the way they manage available bandwidth. The ability to limit and throttle bandwidth while backups are in progress helps minimise the impact on

users and other apps sharing the Internet connection. Moreover, being able to configure multiple bandwidth limits for different times of the day helps optimise the balance between backup performance and the impact on other users. Some cloud service providers, such as AT&T, give customers the option to use a multiprotocol label switching (MPLS) circuit instead of the Internet; this option is relatively cost-effective for customers who already use MPLS. The quality of service (QoS) feature of MPLS lets users label backup data as low-priority traffic, eliminating the impact on other users and applications altogether. This is especially attractive for midsized and large companies with many users and a lot of protected data.

BACKUP MANAGED SERVICE PROVIDERS

Handing off backups to a managed service provider is the quickest way of getting backups into the cloud and the method with the fewest internal IT requirements. MSP offerings are available as pure cloud backup products, where the user installs agents on desktops and servers that directly back up data into the cloud; they're also available as hybrid cloud backup products, where the cloud service vendor provides a managed on-premises gateway to store backup data locally before replication into the cloud.

MSP offerings range from consumer, small office/home office (SOHO), and small- and medium-sized business (SMB) products to cloud backup services targeted at the enterprise. "While the sweet spot for cloud-based backup is still the small to midsized company, larger enterprises have started leveraging the cloud to supplement internal backups, especially for DR [disaster recovery], remote office and end-user data protection," said David Chapa, senior analyst at Massachusetts-based Enterprise Strategy Group (ESG).

Consumer backup services were popularised by Mozy (now part of EMC) and Carbonite. They're pure cloud backup products, licensed to protect a single desktop or laptop, and may not have all the features expected in a business backup product. For instance, the Carbonite service doesn't offer deduplication. "Deduplication is less required in our target market, where the average amount of protected data is less than 50 GB," said Pete Lamson, general manager of Carbonite's Small Business Group. Both Carbonite (with Carbonite Business) and Mozy (with MozyPro) have expanded their offerings into businesses. While Carbonite targets small businesses with a simple and highly affordable backup service, MozyPro is aimed at small and large businesses alike.

Joining Carbonite with a focus on small companies with up to 50 users is Symantec with Backup Exec.cloud. "Backup Exec.cloud has centralised management and provides global visibility to protected hosts, and we try to make backup as simple as possible," said David Mitchell, product manager for Symantec's hosted endpoint protection.

For enterprises, IBM has rebranded and renamed its managed backup service offerings with a focus on resilience: SmartCloud Resilience. The IBM product spans the data protection spectrum from backup and recovery to archival and DR.

Hewlett-Packard's enterprise Electronic Vaulting Service is a managed server backup product powered by Asigra Software; HP's Mobile Infor-

Cloud backup checklist: Key features

FEATURE	REASON FOR RELEVANCE
Encryption of data in transit and at rest in the cloud	Prevents access to the data by cloud service provider staff and other unauthorised users
SAS 70/SS AE16 Type II compliance of the cloud service provider	Ensures the service provider has strong IT controls in place; a must-have for public companies and for industries with additional regulatory requirements
Data deduplication	Reduces storage cost; source-side deduplication also reduces bandwidth requirements
Hybrid cloud backup option	Cached on-premises backups eliminate long restore times of a pure cloud backup solution
Getting data in and out of the cloud via physical device	Options of initial "seeding" of backups and delivery of restore data via physical disk to minimise initial backup and restore times
Incremental forever	Ensures efficient ongoing backups
Subfile-level backup of changed files	Minimises the amount of data to be backed up, especially with large files
Bandwidth features	Throttling and scheduling to minimise the impact of backups on other users

mation Protection uses Autonomy Connected Backup, which HP has just made available as PC Backup Services for the SOHO and SMB markets, and is available through channel partners.

Evault has been offering managed backups since 1997, and the company has one of the most complete and feature-rich cloud backup offerings addressing the needs of small and large companies. Available as pure service, software, and physical and virtual appliances, it can be deployed on-premises, in a hybrid arrangement or as a pure cloud backup product.

Iron Mountain has one of the strongest brands in the backup world but its cloud message changed with the sale of its Connected Backup and LiveVault backup software to Autonomy. Iron Mountain is currently focusing on backup services rather than software development.

"We continue to offer cloud backup services for businesses," said Ken Rubin, senior vice president and general manager of the Iron Mountain health care service. "For the health care and financial services sectors, we provide advanced solutions; for instance, for hospitals we offer a managed backup product with tight integration with all major PACS [picture and archival communication system] systems."

CLOUD-ENABLED BACKUP APPS AND GATEWAYS

While small companies are more likely to opt for the MSP approach, larger companies are more apt to extend their existing backup infrastructure into the cloud using either their existing backup software or a cloud gateway. The incentives to expand the backup infrastructure into the cloud range from replacing off-site tapes with backups in the cloud to leveraging the cloud for backup jobs that can be performed more cost-effectively.

Cloud support in commercial backup applications varies considerably. CommVault Systems has added extensive cloud support and supports a wide range of cloud service providers (AT&T, Amazon, Microsoft, Nirvanix and Rackspace). Supported cloud providers appear as additional backup media and all backup features, such as deduplication, are available when backing up to the cloud. Archival into the cloud with stub support for on-demand retrieval of archived data and block-based replication of changes into the cloud for recovery into a compute cloud service such as Amazon Elastic Compute Cloud (EC2) are a just a couple of features that distinguish CommVault Simpana. Similar to CommVault, both Symantec Backup Exec and NetBackup support backing up into the cloud, but they currently only support Nirvanix. Arkeia Network Backup supports replication of backup sets into Amazon and Nirvanix.

EMC Avamar and NetWorker currently don't have out-of-the-box integration with cloud service providers. Instead, EMC is selling Avamar to MSPs. "We decided on Avamar to power our enterprise backup service because of its efficient source-side deduplication and scalable Avamar Data Store

grid," said Dick Mulvihill, co-founder and managing partner at Hexistor Data Protection Service, a Chicago-based backup MSP.

IBM Tivoli Storage Manager (TSM) doesn't currently support direct backups into the cloud. "We're working with cloud gateway manufacturers such as Riverbed for cloud backup support; cloud backup gateways are simple and quick to set up and have the advantage of locally cached backups for quick restores," said Steve Wojtowecz, vice president of storage software development at Tivoli.

Cloud gateways that move data into cloud storage are available from Nasuni, Panzura, Riverbed Technology, StorSimple, TwinStrata and others. While some gateways are touted as hybrid cloud storage products to extend on-premises storage into the cloud, Riverbed Whitewater's focus is exclusively on cloud backup. Available in different configurations for small businesses to large enterprises, traditional backup applications back up to the Whitewater gateway appliance, which then deduplicates, compresses, encrypts and asynchronously moves data into supported cloud providers (which currently include AT&T, Amazon and Nirvanix). The StorSimple gateway stands out because of its extensive support of Microsoft SharePoint.

CLOUD BACKUP GOES MAINSTREAM

Backup to the cloud is moving from a niche application into the mainstream, especially in the SOHO and SMB sectors, and it's being used increasingly by larger companies to supplement their existing backup infrastructure. The increased adoption of cloud services by public companies and even government agencies suggests that security concerns with cloud services are slowly abating. However, proper due diligence must be taken when evaluating cloud backup, such as implementing solid backup processes and strong controls, to avoid unpleasant surprises. ■

Jacob Gsoedl *is a freelance writer and a corporate director for business systems.*

Storage networking alternatives

All the old standards—FC, iSCSI and NAS—are still going strong, but FCoE and virtualised I/O are waiting in the wings to help remake our storage networks.

BY DENNIS MARTIN

TORAGE NETWORKING RARELY gets much attention, and it's frequently overshadowed by the server and storage gear it links together. But there's renewed interest in storage networking as new or enhanced technologies begin to show up in our data centres. Sure, there's lots to talk about with new server technologies, virtualisation, operating systems and apps, but all those technologies ultimately require a place to store their data, so they rely on storage networking technologies to handle the task.

There's a wide variety of storage networking technologies, with something to fit every budget and storage requirement. Storage networking technologies continue to advance to meet today's growing requirements and to anticipate future needs. Some of these techs are proven and being deployed now or in the near term. Others are relatively new or not yet very well understood, so their future isn't as clear.

THE BROAD RANGE OF STORAGE NETWORKS

Storage networking includes direct-attached storage (DAS), network-attached storage (NAS) and storage area networks (SANs). We'll look at some of the interface technologies used in storage networking, including

the familiar lineup of Fibre Channel (FC), iSCSI and Serial-Attached SCSI (SAS), and some of the newer or less widely used interfaces such as Fibre Channel over Ethernet (FCoE). We'll need to examine file serving interfaces such as Common Internet File System (CIFS) and Network File System (NFS). Finally, we'll explore some I/O virtualisation technologies that have some interesting possibilities.

There's often debate about which storage networking interface is the most popular, with predictions of obsolescence for some storage networking interfaces. After checking research firm IDC's data tracking storage shipments by host interface type, we find that DAS, FC storage, iSCSI storage and NAS are each multibillion-dollar businesses and none of them is going away anytime soon. Furthermore, each one is projected to climb significantly in capacity shipped over the next few years.

DIRECT-ATTACHED STORAGE

DAS is the most common and best-known type of storage. In a DAS implementation, the host computer has a private connection to the storage and almost always has exclusive ownership of that storage. The implementation is relatively simple and can be very low cost. A potential disadvantage is that the distance between the host computer and storage is frequently limited, such as within a computer chassis or rack/adjacent rack.

However, SAS, traditionally known as a DAS type of interface, is beginning to show some storage networking-type capabilities. SAS switches have come to market recently that provide a relatively simple method for sharing storage among a small number of servers while maintaining the low-latency SAS is known for.

NETWORK-ATTACHED STORAGE

NAS devices, also known as file servers, share their storage resources with clients on the network in the form of "file shares" or "mount points." These clients use network file access protocols such as CIFS/Server Message Block (SMB) or NFS to request files from the file server. Because NAS operates on a network (usually TCP/IP over Ethernet), the storage can be physically distant from the clients.

File servers running Windows, or those that need to share storage with Windows clients, use the CIFS/SMB protocol. Microsoft has been enhancing this protocol for several years. Windows 7 and Windows Server 2008 R2 use SMB Version 2.1, which has a number of performance improvements over previous versions. Another implementation of the CIFS/SMB protocol is Samba 3.6, which uses SMB Version 2.0; other implementations of CIFS/SMB use SMB Version 1.0.

File servers running Unix or Linux natively support NFS. There are three

major versions of NFS: NFSv2, NFSv3 and NFSv4. NFSv3 seems to be the most commonly deployed version, and it's adequate for many applications and environments. NFSv4 added performance and security improvements and became a "stateful" protocol. New features in NFSv4.1 include sessions, directory delegation and "Parallel NFS" (pNFS). pNFS was introduced to support clustered servers that allow parallel access to files across multiple servers.

iSCSI

iSCSI provides the advantages of SAN storage while using an Ethernet networking infrastructure. iSCSI has tended to be deployed in small- and medium-sized businesses (SMBs) because of its lower initial costs and perceived simplicity, but it can scale up, especially with 10 GbE technology, and is increasingly finding a place in larger enterprises.

Because iSCSI runs over TCP/IP and Ethernet, it can run on existing Ethernet networks, although it's recommended that iSCSI traffic be separated from regular LAN traffic. In theory, iSCSI can use any speed of Ethernet; however, the best practice is to use gigabit Ethernet or faster. Over the long term, iSCSI will be able to use any of the speeds on the Ethernet roadmap, such as 40 Gbps and 100 Gbps.

Virtualised server environments can take advantage of iSCSI storage through the hypervisor or directly access iSCSI storage from the guest

Storage networking resources from Demartek

DEMARTEK'S LABS offer a number of free storage networking resources on its Demartek Storage Networking Interface Comparison reference page, which has comparisons of many of the block storage interfaces and includes history, roadmaps and cabling information. This information is updated periodically.

For more information on Fibre Channel over Ethernet (FCoE), including test results of FCoE products, please visit the Demartek FCoE Zone.

The Demartek iSCSI Zone provides research and testing data on iSCSI products, and includes an iSCSI Deployment Guide.

virtual machines (VMs), bypassing the hypervisor.

As the adoption rate of 10 GbE technology increases, iSCSI becomes increasingly attractive to organisations as they examine their long-term data centre plans. Many of the iSCSI storage systems available today have all the advanced storage features such as replication, thin provisioning, compression, data deduplication and others that are often required by enterprise data centres. For many modern storage systems, iSCSI is available as a host interface along with FC and other interfaces.

Storage networking lingo

10 GbE	10 Gigabit Ethernet
CNA	Converged network adapter
DCB	Data Center Bridging
FC	Fibre Channel
FCoE	Fibre Channel over Ethernet
HBA	Host bus adapter
iSCSI	Internet SCSI
MR-IOV	Multi-Root I/O Virtualisation
NAS	Network-attached storage
NIC	Network interface card
PCIe	PCI Express
SAN	Storage area network
SAS	Serial-Attached SCSI
SATA	Serial Advanced Technology Attachment
SR-IOV	Single Root I/O Virtualisation

FIBRE CHANNEL

Fibre Channel has been used as both a device-level disk drive interface and a SAN fabric interface, and has been deployed for approximately 15 years. FC carries the SCSI command protocol and uses either copper or fiber optic cables with the appropriate connectors. FC speed has doubled approximately every three or four years, with 8 Gbps products becoming available in 2008 for SAN fabric connections and 16 Gbps products just beginning to emerge. All high-end storage subsystems and many mid-range products use FC as either the only host interface or one of multiple interfaces.

Fibre Channel is used as a disk drive interface for enterprise-class disk drives, with a maximum interface speed of 4 Gbps to an individual disk drive (the speed of the interface shouldn't be confused with the transfer rate of an individual disk drive). The industry is moving away from FC as an enterprise-class disk drive interface and shifting to 6 Gbps SAS for enterprise drives, including hard disk drives (HDDs) and solid-state drives (SSDs).

FC provides excellent performance, availability and scalability in a lossless network that's isolated from general LAN traffic. Fibre Channel infrastructures are common in large data centres where there are full-time data storage administrators. It's not uncommon to see FC fabrics with hundreds or thousands of active Fibre Channel SAN ports.

Use cases for 16 Gbps FC include large virtualised servers, server consolidations and multi-server applications. The increasing acceptance of SSDs for enterprise workloads will also help consume some of the increased bandwidth that 16 Gbps FC brings. In addition, storage vendors are already working on a 32 Gbps FC SAN interface that's expected to appear in products in three or four years.

FIBRE CHANNEL OVER ETHERNET

Fibre Channel over Ethernet is a new interface that encapsulates the FC protocol within Ethernet packets using a relatively new technology called Data Center Bridging (DCB). DCB is a set of enhancements to traditional Ethernet and is currently implemented with some 10 GbE infrastructures. FCoE allows FC traffic to run over a lossless 10 Gbps link while maintaining compatibility with existing Fibre Channel storage systems.

FCoE introduces a new type of switch and a new type of adapter. Ethernet switches capable of supporting FCoE require DCB and the new host adapters are known as converged network adapters (CNAs) because they can run Ethernet and FC (via FCoE) at the same time. Some of the CNAs have full hardware offload for FCoE, iSCSI or both, in the same way that Fibre Channel host bus adapters (HBAs) have hardware offload for Fibre Channel. DCB switches are capable of separately managing different traffic

types over the same connection, and can allocate percentages of the total bandwidth to those differing traffic types. By combining the previously separate Ethernet and Fibre Channel switches, adapters and cables, the long-term costs of storage and data networking can be reduced.

As enterprises plan new data centres, or new server and storage infrastructure, FCoE and DCB technology should be carefully examined. They offer the potential for increased performance, a reduction in the number of adapters needed and a commensurate reduction in electricity needs while working with existing Fibre Channel infrastructure.

I/O VIRTUALISATION

I/O virtualisation is about virtualising the I/O path between a server and a storage device, and is therefore complementary to server virtualisation. When we virtualise, we decouple the logical presentation of a device from the physical device itself to use the resources more effectively or to share expensive resources. This can be done by splitting the device into smaller logical units, combining devices into larger units or by representing the devices as multiple devices. This concept can apply to anything that uses an adapter in a server, such as a network interface card (NIC), RAID controller, FC HBA, graphics card and PCI Express (PCIe)-based solid-state storage. For example, NIC teaming is one way of combining devices into a single, "larger" device. Virtual NICs are a way to represent multiple devices from a single device.

FCoE and DCB offer the potential for increased performance, a reduction in the number of adapters needed and a commensurate reduction in electricity needs.

A pair of related technologies known as Single Root I/O Virtualisation (SR-IOV) and Multi-Root I/O Virtualisation (MR-IOV) are beginning to be implemented. SR-IOV is closer to becoming a reality than MR-IOV, but both provide some interesting benefits. These technologies work with server virtualisation and allow multiple operating systems to natively share PCIe devices. SR-IOV is designed for multiple guest operating systems within a single virtual server environment to share devices, while MR-IOV is designed for multiple physical servers (which may have guest virtual machines) to share devices.

When an SR-IOV-capable adapter is placed in a virtual server environment and the hypervisor supports SR-IOV, then the functions required to create and manage virtual adapters in the virtual machine environment are offloaded from the hypervisor into the adapter itself, saving CPU cycles on the host platform and improving performance to nearly that of

a physical server implementation. Many Ethernet adapters, FC HBAs and some RAID controllers are SR-IOV capable today.

MR-IOV takes I/O virtualisation a step further and extends this capability across multiple physical servers. This is accomplished by extending the PCIe bus into a chassis external to the servers, possibly at the top of the rack; all the servers in the rack would then connect to this PCIe chassis using a relatively simple PCIe bus extender adapter. Network, graphics or other adapters, especially expensive adapters, can then be placed into the external chassis to allow sharing of the adapters by multiple servers.

SR-IOV and MR-IOV work with server virtualisation and allow multiple operating systems to natively share PCIe devices.

An interesting application of this type of technology would be to use SR-IOV- or MR-IOV-capable RAID controllers or SAS/Serial Advanced Technology Attachment (SATA) adapters for moving guest VMs without the need for a SAN. Also, imagine an SR-IOV-capable NIC that could service requests for connections between guest virtual machines that were in the same physical server, eliminating the need for an external switch.

The long pole in this tent is getting support from the hypervisor vendors. As of this writing, only Red Hat Enterprise Linux 6 supports SR-IOV for a limited set of NICs. Microsoft has been rather tight-lipped about features in the next version of Windows, but it wouldn't be too surprising to see some SR-IOV support in the next version of Windows Hyper-V. It's not known at this time if SR-IOV support will show up in VMware products anytime soon. ■

Dennis Martin *has been working in the IT industry since 1980, and is the founder and president of Demartek, a computer industry analyst organisation and testing lab.*

Determining the real cost of storage

Vendors tout dollars per gigabyte per I/O, but figuring out what a data storage system will really cost your company is a much more complicated process.

IF YOUR JOB involves storing data, you already know storage eats up budget faster than just about anything else in IT. But as daily practitioners, we rarely notice just how much storage really costs. The marketing hype for data storage products stays focused on magic bullets like "more capacity per dollar" or "more I/O per euro," but the cost of storage is about more than that.

One of the best ways to consider the true cost of storage is to think about what's required to store a single piece of data over its entire lifetime. This is called the "lifecycle cost of data storage" . This type of bottom-up look at storing a piece of data over a period of time not only helps us understand what data storage truly costs, but helps us determine what we should be looking for when we're shopping for data storage products.

The classic challenge for the strategic storage manager is that the vast majority of data created in the data centre starts its life on primary storage, so storage purchasers tend to fixate on these costs. But capital costs are actually more of a distraction than a real representation of what storage costs. Even worse, the costs are even more skewed when you consider the dissimilar products that are typically part of most storage environments. Even the total costs of primary data storage are often misunderstood. Primary storage is often poorly provisioned and underutilised, a problem that's compounded as more storage systems are added and more features are licensed. And you're bound to see at least a linear increase in the time and effort required to manage the storage, especially when time-consuming tasks like data migrations are required.

But the cost of storing data goes beyond primary storage. Each piece of stored data is surrounded by an ecosystem of information services. Data protection is the most obvious, and it typically consists of several parts such as the management of multiple disk and tape tiers, and the logistics of getting protected data off-site. A holistic look at the cost of

data protection alone is likely to dwarf the capital costs of primary storage.

There are plenty of other costs besides data protection. Regulatory compliance and the changing nature of intellectual property encourage ever-longer retention of data. To hold onto more data for longer periods of time, companies must spin up entire infrastructures and establish practices around information archiving, search and retrieval. Disaster recovery is yet another data protection function that can't be ignored, and its cost can be significant. The replication engines, bandwidth consumption and duplicate storage infrastructure required for disaster protection can easily induce some serious sticker shock.

Taneja Group has done extensive benchmark testing of hypervisors for what we refer to as virtual machine (VM) density; it's based on the idea that different hypervisors are more or less efficient, so that given matching hardware, some will be able to run more VMs or deliver better performance. When considering all the hardware, licensing, management effort and consumption of data centre resources, this can have an enormous bottom-line impact. Recently, we've also focused on "storage density," which is a similar concept. It considers how a product or technology can help you shrink your data footprint when considered across storage capacity, storage systems, bandwidth consumption and human interaction.

It's not really a new idea; rather, we're just now starting to see solutions that attempt to bring together capabilities that used to come from many separate storage products. In part, it's also a reaction to changing IT practices in the enterprise; with virtualisation becoming mainstream, data protection practices have had to change, and it's not uncommon to see primary storage products that incorporate some aspect of data protection. Similarly, data storage products are featuring better optimisation, and secondary storage systems are raising performance and becoming more general purpose.

A number of vendors try to communicate this message in terms of storage efficiency. But storage efficiency often implies a sort of soft, qualitative comparison, and it can fool users into thinking that improving storage might just be about tweaking one or two of the most obvious dimensions of efficiency, such as capacity optimisation. Whether we call it storage density or storage efficiency, it's more than a single dimension.

We've explored various examples of this functional convergence creating greater storage density in recent lab exercises. I see those exercises as representing the market as a whole; each vendor in this consolidating, scaling-storage landscape is striving to enhance the value and competitiveness of their offerings. But the real winners are users, who are finally getting storage technologies that can help enterprises scale their storage infrastructures through better storage density rather than sprawl. ■

Jeff Boles *is a senior analyst at Taneja Group.*

Occupy Storage!

Data storage technologies keep getting better, but storage vendors may just be up to their old tricks.

'M WRITING THIS COLUMN in a hotel room in Newton, Massachusetts, not far from the Hopkinton home of the storage hardware market share leader, EMC. Anyone familiar with my work knows my views, which tend to be quite critical of both EMC's products and its marketing and sales techniques. These views largely pre-date the age of storage in which a handful of behemoth vendors have gobbled up most of the smaller fry, reducing the options available to consumers for solving storage challenges in the process. I've had other axes to grind with Hopkinton over my 30-year-plus career in IT, and have been open and vociferous in expressing my views. Frankly, I was surprised and intrigued to be offered a column in this magazine under the circumstances since the advertising revenue that keeps the publication afloat comes from precisely those vendors with whose products I so frequently find fault.

All of the above notwithstanding, I thank you, readers, for indulging me with some of your time and I promise to try not to waste any of it. I understand the challenges that most of you are facing. You're shouldering the work of what used to be many, tasked with delivering ever higher service levels to your businesses with ever shrinking budgets, and at the same time endeavoring to wrangle a bunch of disparate storage technologies into some sort of coherent and manageable resource.

I read recently that more than a trillion transactions traverse the wires, cables and wireless spectrum of a medium-sized business data centre every day. Those are a trillion miracles—photons, electrons and radio waves that successfully complete round trips across the most hostile environments imaginable, carrying requests for data and returning responses to users and applications—and you are the miracle workers who make them happen.

Of course, there's no recognition of this and no time to rest on one's laurels even if you were recognised. Truth be told, life is hard in storage

land and it's about to get a lot harder.

We're seeing vendors return to old tricks, like isolating value-add functionality on array controllers where it can be used to lock in consumers and lock out competitors. In general, this design approach has limited merit because it inhibits cross-platform manageability, increases data routing complexity, drives up the cost of commodity array components, adds what are usually obscene software licensing costs to the kit, and introduces greater risk of failure into the data centre environment. Embedded value-add software, vendor engineers have told me, is usually poorly validated because the interoperability test matrix is simply too complex and time consuming to undertake and complete. Thus, it should come as little surprise that the 3,000 companies polled by CA Technologies earlier this year reported they had accrued more than 127 million hours of downtime last year, partly due to storage-related outages ("The Avoidable Cost of Downtime," May 2011, CA Technologies).

And, in this gilded age, it goes without saying that a proper behemoth storage vendor must also offer a "cloud architecture." Using proprietary hardware/software stacks, each one is seeking to advance its own mainframe "mini-me" that combines a server hypervisor with a set of network protocols supported only by the vendor's own switches and its "signature" value-add storage gear to deliver the ultimate "one-stop shop." They have enlisted analysts to preach the gospel of "single source" again. One Forrester analyst recently wrote that buying all technology from one vendor is "the only real way" to drive cost out of storage. That couldn't be further from the truth, but it's the mantra vendors are humming into the receptive ears of non-technical decision makers in the front office of every firm I visit today. Many pine for the orderliness of the IBM mainframe data centre of the 1970s while forgetting how the loss of leverage over a vendor translated to extraordinary capital costs in hardware and software, and delays in obtaining needed fixes and changes to products. We've forgotten the lessons of the past and are poised to repeat them.

Or maybe not. I invite everyone who's interested to bring a tent, sleeping bag and their favorite storage issues so we can start an entirely new discussion: one about fixing the broken storage model before it fixes us. This gilded age promises to benefit the 1% of companies that still have deep pockets and unlimited budgets for buying storage. The other 99% need to start exploring viable alternatives. ■

Jon William Toigo *is a 30-year IT veteran. He is CEO and managing principal of Toigo Partners International, and chairman of the Data Management Institute.*

"Big data" conspiracy theories abound

Could the latest and greatest buzzword in the storage biz be killing off some of the most useful storage technologies around?

'VE GONE OFF about this "big data" thing on more than one occasion, about how it's mostly marketing hype that vendors hope to turn into sales. But the whole deal is starting to give me the creeps, and it's not just because the phrase "big data" is being burned into our collective cerebrum with astonishing efficiency.

I'm still struggling with the idea that there's a solution appropriate for processing big files like high-def digital movies and lots of small files like tweets. Given the number of vendors already piled onto the big data bandwagon, it seems like there are dozens of these so-called solutions floating around. So I have trouble getting over that big data hump because any term that refers to completely opposite things simultaneously is questionable in my book.

I'm not just on a semantical rant here. The big data spectre goes deeper than that. If you can look past its dual personality, a pretty clever play for corporate egos is at work here: "Of course our data is big; we wouldn't want it if it weren't!" It's an emotional ploy that feeds into the kind of self-importance that says everything we do/say/create is important and should be kept/mined/analysed. Big is beautiful, and our data is bigger than yours.

Here comes the conspiracy theory part. Why is it that so many companies today are awash in big data (if they really are)? Sure, there are a lot more ways of creating stuff than before, and everybody seems to be walking around with a data-creating machine in each pocket, but all of a sudden we have to figure out what to do with the stuff. Not too long ago, a few startups appeared with products—rudimentary maybe, but real products—that could help us pore through all the stuff we stored to determine what's worth keeping and what needs to be deep-sixed. Those data classification products had a lot of promise; they came from companies such as Abrevity, Arkivio, FileTek, StoredIQ and Kazeon, and it looked

like they would be the cornerstones of storage management operations from tiering to archiving. The premise was simple: You have to know what you've got before you decide what you need to do with it.

Maybe it's too simple. If users get a better grip on what they're storing and what they shouldn't be storing, they might—gasp!—buy less storage. So it wasn't a big surprise that most of those classification vendors disappeared, some simply into the ether and others into the portfolios of (guess who?) storage vendors, where, for the most part, they've just withered away.

Apparently, knowing what to keep and what to chuck is a little threatening if your company sells the storage to stash all that stuff on. With those pesky data classification apps out of the way, users could get back to doing what they always do, amassing untold heaps of data and buying more disk to store it.

So now you have big data and it's a big problem, and vendors are all too happy to help. They have big data storage systems and can supply state-of-the-art big data processing tools so that firms like yours can crunch through the piles of data you've been encouraged to keep. And as you plow through the knee-high drifts of data, you'll probably determine your employees spend too much time tweeting, updating their Facebook pages and using the SAN to save photos of their kids. And you're left to wonder why you're keeping it all.

But data classification isn't the only technology casualty of the big data juggernaut. A couple of years ago there was buzz around the arrival of a few products that promised to cut our primary data storage down to size using deduplication and compression. But the two leading startups were scooped up by megavendors, and now primary dedupe and compression sit like a couple of old boxcars on an abandoned railroad siding.

And while you're still reeling from the big data drubbing you're getting from vendors, watch out for the cloud haymaker they're about to land. Because cloud storage is perfect for big data, right? And buzzwords tend to get lonely if they're left on their own. ■

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