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OPTIMIZING ENTERPRISE STORAGE

As storage demands grow dramatically, advances in technology are helping organizations keep pace.

Executive Summary

Storage will never be the hot topic in enterprise IT— until the day that there's not enough of it, it's not fast enough or the data disappears. Like any infrastructure element, storage is incredibly important and generally underappreciated.

Storage managers are generally risk-averse and move slowly — for good reason. However, technology trends such as Big Data, virtualization, cloud computing, bring-your-own-device (BYOD) initiatives, solid-state drives (SSDs) and mobility are changing the underlying requirements for storage speed, capacity and availability.

Just the sheer volume of data being squirrelled away requires ever-increasing amounts of storage space and vigilance. This can prove distracting for storage specialists trying to focus on strategic initiatives like enhancing performance, maintaining sufficient archiving and keeping data searchable.

As enterprises change their computing infrastructures to respond to these trends, and as the world of storage technologies moves forward with faster and higher-capacity systems, storage managers must stay ahead of the curve.

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Overview

It has never been easier or less expensive to store information. A combination of dramatic decreases in cost-per-byte for storage devices and equally dramatic increases in performance of storage subsystems make storing data — lots of data — fast and simple.

At the same time, organizations are generating terabytes and petabytes of data, all looking for a home. This includes:

- Multimedia streams from Voice over IP (VoIP) systems, web and in-person conferences, security cameras and monitoring systems
- Transaction logs from database, email and web servers, all with customer data in ever-more-minute detail
- Continuous information coming from manufacturing and testing systems
- Hefty PowerPoint presentations, high-resolution images and other data from the day-to-day work of running an organization

IT staffs face two challenges when dealing with the ever-increasing demand for storage. First is the inevitable scramble to add capacity in a controlled and economical way. Storage costs have dropped by four orders of magnitude — that's a factor of 10,000 — over the past 20 years.

With price changes this dramatic, no one wants to buy storage they don't need today, because it will cost less tomorrow. IT staff must accurately predict storage volume requirements far enough out that the storage is always available as the organization needs it, but without wasting money today on capacity that won't be needed for a few years.

The second challenge is how to address capacity requirements in an enterprise-sensitive context. Increasing an organization's storage capacity isn't as simple as heading to the local electronics store and buying the latest external USB hard drive. But few outside of the data center understand the difficult challenges in building storage systems that meet business continuity goals with backups; necessary performance requirements for speed and access time; stringent legal requirements for archiving and records management; and business use requirements with searching, indexing and organizational tools.

Both of these challenges — raw capacity and enterprise suitability — make things difficult for IT departments that face budget and staffing limitations. At the same time, IT staff must focus on innovations that improve their ability to deal with the ever-growing mountains of data, such as solid-state devices, storage virtualization and highly distributed storage.

Technology Trends Affecting Storage

For the enterprise, storage is a utility. Storage supports other applications but is not an end in itself. This means that storage needs are affected by shifts in other computing technology.

Right now, four significant trends are influencing IT in all types of organizations. Each of these trends also brings a new emphasis that storage managers should consider as they plan the next stages of storage maintenance, upgrade and expansion.

Trend	Effect on Storage Devices and Storage Applications
Virtualization	Virtual machine sprawl requires increasing amounts of high-performance storage. Input-output (I/O) bottlenecks at storage area networks must be anticipated and mitigated. Live migration of a virtual machine file system between separate storage systems can require massive inter-SAN bandwidth between systems and data centers.
Cloud computing, cloud services	Storage in the cloud represents an alternative for some types of data. Cloud applications represent a backup and business continuity liability for storage teams to resolve.
Bring-your-own-device (BYOD) and consumerization of IT	Having more data on uncontrolled devices makes data retention difficult to manage. Potential problems come from the inevitable mix of business and personal data on devices.
Mobility	Bandwidth constraints of wireless networks affect performance of storage systems and end-user experience.

Trend 1: Virtualization

The flexibility, reliability and expandability provided by virtualization technologies such as VMware vSphere, Citrix XenServer and Microsoft Hyper-V have made them ubiquitous in data centers. They are dramatically changing the way that storage supports server and application provisioning and deployment.

Highly desirable features, such as hardware redundancy and storage replication, are now much simpler to deploy thanks to the abstraction layer provided by virtualization. However, the few downsides of virtualization, such as virtual machine

"sprawl" and requirements for massive-bandwidth SANs, can create headaches for storage managers.

Virtualization has been a quiet revolution, because system managers can deploy the technology slowly and methodically with few "big bang" impacts. Because virtualization trades off some costs (physical servers, data center space) for others (software and management costs of virtualization infrastructure), the added expense and overhead of virtualization is easily absorbed into existing budgets.

However, as system managers slowly grow their virtualization farms, they run into other limitations in storage infrastructure, such as SAN input/output operations per second (IOPS) ceilings, SAN expansion limits, storage network bandwidth bottlenecks and backup window constraints that may not have been important in the past.

Virtualization will remain a critical data center technology. However, system managers are realizing that it has far-reaching effects and that reliable, high-performance storage is needed for effective use of virtualization technologies.

Trend 2: Cloud Computing

CEOs everywhere are pushing their IT teams to move something — anything — to the cloud. Storage managers aren't being tagged as primary cloud consumers because cloud storage is a hard sell:

- Bandwidth is rarely sufficient for large data sets, unless they are built in an incremental fashion (such as a few megabytes a day).
- Backup and data retention are big holes in any cloud storage provider strategy, and many organizational legal teams won't accept the potential liability.
- Cloud's traditional cost savings argument for applications, computing and support doesn't work as well when storage is considered. This is because organizational costs for "low-value" storage (the tier usually provided by cloud services) are often lower than the cloud can offer.

If cloud computing has anything to teach storage managers, though, it's the business model: Pay as you go, and buy as much as you need. Storage has traditionally been bought in large chunks, demanding high acquisition and maintenance costs ahead of IT requirements — and providing relatively little flexibility when demand suddenly spikes. The cloud model offers lessons to storage managers and challenges them to rethink how they acquire and provision storage.

Trend 3: BYOD and the Consumerization of IT

BYOD and the consumerization of IT are two sides of the same coin, a tectonic shift in the way organizations view IT. Now that everyone in an organization has access to inexpensive personal computers, handheld devices, Internet connectivity and world-class Internet-based applications, IT departments are dealing with users who want to take the high-quality experience they have at home and bring it with them to work, often even using the same smartphone, tablet or notebook PC.

As organizations struggle with BYOD and the high expectations that consumerization brings, storage managers have to worry about valuable corporate data residing on devices that aren't owned or even managed by the organization. Keeping this data secure from hackers may be the responsibility of the security and network teams, but the storage team has to make sure that original content on end-user devices is captured in enterprise data stores, backed up and properly retained.

Mobile devices don't share the same file systems or storage paradigms as a typical desktop computer. This means that simply backing up personal devices doesn't help; all the storage manager ends up with is an opaque blob that can be used to re-create the device in the future. And backing up users' personal devices also means that the organization is now storing their personal information — all those family pictures, softball videos and Grateful Dead concert soundtracks are mixed in with corporate data.

Storage managers must solve these problems of capturing, decoding and properly retaining the data on end-user devices to make BYOD work in the organization.

Trend 4: Mobility

Mobility isn't so much a trend as it is a new way of life. What started before the turn of the century as a series of pressures that included falling hardware costs, increasing real estate expenses, rethinking of work habits and renewed attention to lifestyle has now become a completely mainstream way of thinking about teams, productivity and daily work. Now that notebook sales represent two-thirds of new computers sold, it's clear that mobility within the enterprise is not just a fad but here to stay.

Storage managers must carefully consider the impact of mobility initiatives within their organizations to be ahead of the curve in supporting mobility. Previous assumptions about devices and data are going out the window: Wireless bandwidth won't always support device backups; devices are not always-on, creating a similar problem; virtual private network (VPN) connectivity can add a further drag to communications between end-user mobile devices and back-end storage servers; and users now need to stage ever larger amounts of data on their mobile devices to give better performance when bandwidth or connectivity suffers.

All of these challenges represent an opportunity for storage managers to rethink their hierarchical storage models and re-engineer how devices connect with back-end storage systems. More important, mobility gives storage managers a way to move into a stronger and more visible partnership with enterprise application and data owners.

Never Enough Storage, Never Enough Budget

The need for storage seems infinite. Existing applications continue to pile on data every moment, while new applications are designed with storage-hungry data sets. With storage density increasing continuously, this additional density is being snapped up at a dizzying rate, with many organizations having at least 10TB of storage under management.

As a result of this rapid storage growth rate, enterprises need greater storage budgets just to keep pace.

Unfortunately, storage managers don't have a lot of input into application development, design and system management, so influencing storage growth in the enterprise seems like a long shot. However, some key factors driving storage growth can be influenced by savvy storage managers to help slow things down and fit in ever-tightening budgets.

FACTOR: Virtual machine sprawl. It's easy to spin up new virtual machines (VMs), so they tend to grow without limits.

WHAT STORAGE MANAGERS CAN DO: Improve management. Work with the VM infrastructure team to be sure that VMs are being provisioned properly, with thin provisioning where possible. Encourage customized configurations that don't allocate more storage than necessary. Most important, help push for a VM lifecycle process so that VMs don't balloon out of control. By investing in good management tools and adhering to strong processes for spin-up and spin-down of VMs, storage managers can slow growth without affecting operations.

FACTOR: Database backups. Database administrators frequently forget to delete backups. Since databases can be hundreds of gigabytes, a few spare backups here and there can cause storage nightmares.

WHAT STORAGE MANAGERS CAN DO: Build trust and empower. Work with database administrators to ensure that they are comfortable with the technologies available for backup and restoration, such as solid enterprise database and disk backup tools along with SAN snapshots. If appropriate, administrators should be able to create and release their own snapshots. Gain trust by showing that enterprise backups can capture the state of a database accurately and restore it quickly. VM infrastructure teams also need to learn the benefits and limitations of snapshots, as they can use the same technology to reduce the impact of short-term VM testing.

State of the Market

The storage market has segmented into many small pieces, as manufacturers have developed different products to handle the diverse demands of today's enterprises. Traditional market research firms, such as IDC, break the market down for reporting purposes, differentiating between storage area network (SAN) vendors, network-attached storage (NAS) vendors, external storage array vendors and so on. Storage managers will see the same names in many of these segments: EMC is usually the largest in any market segment, with HP, NetApp, IBM and Hitachi Data Systems all participating as major vendors.

However, storage managers should be aware that the big names together only make up about three-quarters of the market space. Numerous smaller companies have earned their place by delivering solid products at attractive prices.

In a risk-averse environment such as storage, managers are unlikely to sign off on purchases from unknown vendors when mission-critical applications are on the line. However, less-critical applications with large storage requirements are excellent places to start saving money by diversifying storage portfolios in the data center.

FACTOR: Many copies of the same thing. Backing up 1,000 Windows systems creates 1,000 nearly identical copies of Windows. Virtualization can create the same numbers as well. This adds up fast, as operating systems bulge with patches and applications.

WHAT STORAGE MANAGERS CAN DO: Invest in deduplication technology. Dedupe is one of the low-hanging fruits of the storage industry, and storage managers should be looking at the integration of dedupe technology into their storage systems to handle this sort of issue.

FACTOR: No one knows where the storage is going. Application managers and development teams don't mean to waste storage. They often just don't know the impact of what they're doing.

WHAT STORAGE MANAGERS CAN DO: Inform and report. Giving IT teams useful web-based reports on how storage is being used encourages them to use the limited resource wisely. Many storage reports are too detailed or expressed in terms that won't make sense to other parts of the IT team. The key is to provide the right information at the right level of detail, with drill-down by application, organizational unit and type of storage.

FACTOR: A lack of perspective on where the storage is going. No, it's not useful for an organization to store a gigabyte of a user's personal photos. But using 3TB to store two forgotten copies of a test Enterprise Resource Planning (ERP) system is far more wasteful.

WHAT STORAGE MANAGERS CAN DO: Don't sweat the small stuff. Storage managers should focus on their own low-hanging fruit, finding the large consumers and working with them to limit consumption.

Big Data and Storage

Big Data is a topic of intense interest to storage managers. It is often described in terms of three V's: volume, variety and velocity. Big Data refers to digital information that is massive (volume) and varied, and that arrives in such waves (velocity) that it requires advanced technology and best practices to sort, process, store and analyze.

As the name suggests, Big Data requires big storage to handle data sets that are constantly growing. However, traditional tiered storage systems don't handle very large, unstructured file systems very well. Major storage vendors have generally gone the acquisition route to widen their product portfolio. For example, EMC offers products for Big Data under its EMC Isilon brand, an acquisition it made in 2010. Similarly, Hitachi has HNAS, from BlueArc; HP has StoreAll, from IBRIX; and so on.

The defining characteristic of these systems is that they can "scale out," rather than "scale up." In a system that scales up, the storage manager simply buys more shelves of disks and adds them to an existing controller, until the controller runs out of capacity and input/output operations per second. Scale-out assumes that the data volumes are growing, but that a traditional tiered approach to access will work and that more capacity is needed, not more IOPS.

Storage and Network Topologies

Because storage represents the persistent stored knowledge and operations of an organization, everyone in IT wants to take a safe position and minimize the risk of data loss or the interruption of operations. This constraint affects many discussions about how to best build storage systems.

Experts agree that direct-attached storage (DAS) is decreasing in popularity in the data center. The strong benefits of storage virtualization make disk drives stuck in a single server less attractive. Locally attached storage can't be optimized for performance, it can't be easily grown or shrunk in size, and it can't be easily transferred to another host in the case of hardware failure.

Building reliable directly attached storage also creates a management burden and serious cost inefficiencies. Local storage remains popular as a boot and diagnostic device, and can be useful in some cases as a temporary staging area for logs or for page and swap files. But the era of physically large application servers, with eight or 16 disks in them, seems to be passing in favor of network-based storage.

This has pushed enterprises of all sizes to both network-attached storage (NAS) and SAN technology. While NAS still has a niche market, the clean speed and low overhead of SAN makes it an obvious choice in almost all storage deployments. The hot question for storage managers is not NAS versus SAN, but Fibre Channel SCSI versus Ethernet iSCSI.

On the network side, Fibre Channel has a strong presence in the storage world and dominates most enterprise storage area networks. Fibre Channel, currently shipping at speeds up to 16Gbps, differs greatly from traditional Ethernet and TCP/IP networks. With roots stretching back to high-performance computing initiatives more than 25 years ago, Fibre Channel has its own layering, its own signaling protocols, its own transport protocols and its own session layers.

This means that interoperability between Fibre Channel networks and other high-speed local area networks (LANs) in enterprises is poor and unlikely to get better. Many of the differences are due to fundamental incompatibilities, as Fibre Channel is a "smart network" technology that requires considerable in-the-network intelligence, while Ethernet and TCP/IP push most of the intelligence and management to the edges of the network.

The incompatibilities haven't kept vendors from trying to unify Ethernet and Fibre Channel on the same 10Gbps wire using the Fibre Channel over Ethernet (FCoE) technology (speeds lower than 10Gbps are not supported due to the lossless nature of Fibre Channel). These initial FCoE products are mainly aimed at converged adapters on the server side, combining data port and Fibre Channel traffic on the same Ethernet wire.

Unfortunately, Fibre Channel can't simply be transmitted over existing Ethernet hardware, because Fibre Channel makes greater demands of the network than Ethernet does. Fibre Channel's protocols expect a lossless network, and Fibre Channel switches are more active in routing and access control (security) than their Ethernet brethren.

For example, Fibre Channel fabrics actively try to spread the load across multiple paths to increase performance, while standards-based Ethernet keeps all traffic for the same virtual LAN on the same path. Thus, FCoE isn't just a buzzword but an extension of Ethernet switching technology to support the additional requirements of Fibre Channel networks.

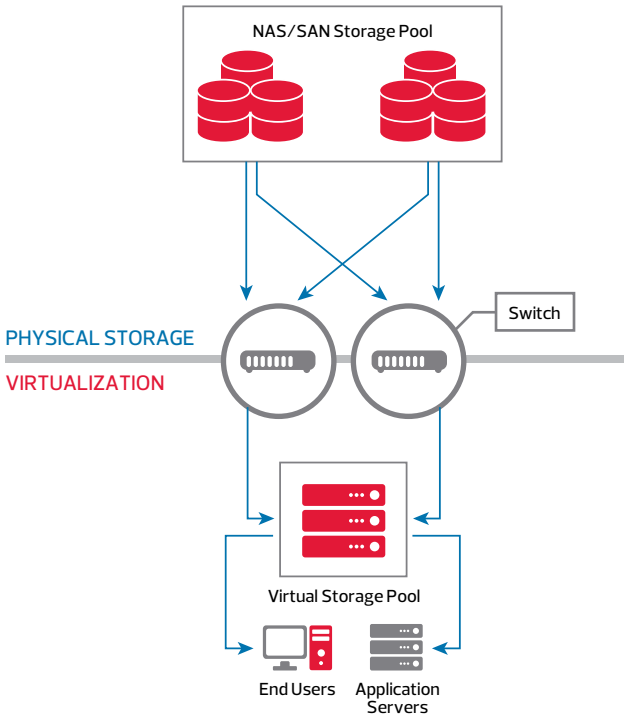
One of the issues storage managers need to be aware of with FCoE is "multi-hop" standardization. Most FCoE is single-hop: one piece of Ethernet between the server and the Ethernet

switch, and then a conversion back to FCoE for the rest of the journey through the network. Multi-hop should give the ability to carry Fibre Channel across multiple Ethernet switches end-to-end between SANs and servers.

This seems like an obvious use to many network engineers, but multi-hop is a sensitive and difficult subject in the world of Fibre Channel. Storage networking engineers don't even agree on the meaning of multi-hop, making it difficult to compare the capabilities of different Ethernet switch devices and making interoperability even more complex.

The jump from Fibre Channel SCSI to Ethernet with iSCSI seems inevitable, for two reasons: Ethernet is jumping speeds, to 40GB and 100GB (while Fibre Channel still doesn't have wide availability of 32GB), and Ethernet is much less expensive to buy and manage. However, the momentum, marketing and tradition behind Fibre Channel is so strong that it will be many years before Fibre Channel succumbs to Ethernet.

Storage virtualization: associated with storage efficiency as well as a way to cut data center operational costs



Hardware and Software Trends

Most storage technology changes are small transitions, such as speeding up disks from 10,000 rotations per minute to 15,000 rpm. However, two significant changes in the world of storage are working together to increase performance and better match storage needs to available equipment: solid-state drives and storage resource management (SRM).

The traditional multitier storage architecture remains prevalent. However, storage managers find themselves having to deal with a wide variety of arrays that include multiple storage techniques (solid-state versus spinning media), connection technologies (Serial Attached SCSI or SAS and SATA), speeds (5400, 7200, 10,000 and 15,000 RPM) and sizes (2.5-inch and 3.5-inch). This makes it difficult to choose a technology mix that delivers the right number of tiers of storage in the right capacities.

While the biggest disruptive force in storage is clearly solid-state drives, the huge cost differential between SSD and standard hard-disk drives (HDDs) will make the transition from HDD to SSD a slow one. Current pricing for SSDs is roughly 5 to 10 times higher than HDDs, although the difference drops every year. In storage arrays, the pricing of an integrated subsystem remains at a higher differential.

Still, the rate of change is not fast enough to stop sales of HDD devices. In some technologies, a clear inflection point made it obvious that managers should stop buying a certain product (such as 100-megabit-per-second Ethernet) and start buying another (such as 1Gbps Ethernet) exclusively.

This inflection hasn't been reached with SSDs. Thus, SSDs are being leveraged as a high-speed cache sitting in front of the highest-performance (Tier 1) storage systems. In this position, they reduce latency and increase IOPS. Within five years, however, SSDs should be expected to jump from 20 percent of enterprise storage to 80 percent.

At this time, a full storage array based on SSD technology should be reserved for critical performance applications that require extremely high bandwidth and very low latency for all types of reads and writes. The key factor for storage managers to understand is that SSD has a very high dollar-per-gigabyte cost. However, the speed of SSDs gives them a very low dollar-per-IOPS cost, less than a tenth of the equivalent HDD technology.

Storage managers have a critical need for software tools to help understand the performance of storage subsystems and the applications using them. Many application managers have only the vaguest idea of their storage performance requirements, making any decision based on the declaration that an application "needs super-fast storage" or "does a lot of random-access writes" often a poor one. Storage usage and performance monitoring software is a critical investment to optimize the use and sizing of storage tiers.

This software goes by the generic term of storage resource management. Although the ideas behind SRM date back to 2000, the original area of usefulness extended only to hyper-scale organizations, such as supercomputer centers. As enterprises grow their three- and four-tier storage systems, SRM has become a critical tool to properly size and migrate application loads, with more than a dozen vendors providing products in this space.

Software-defined Storage

Software-defined networking is a topic of major interest in IT departments, so it stands to reason that software-defined storage would carry similar interest. However, few can agree on what software-defined storage means, and it has become a marketing buzzword without a strong consensus on its definition.

In software-defined networking, engineers make a clear distinction between the networking hardware doing actual packet switching and routing, versus the policy engine that defines the routing tables. In the same sense, software-defined storage would have an additional layer of software that takes multiple heterogeneous elements and creates a larger whole that presents itself as a unified storage system to applications. What that really means is unclear.

Today, the term software-defined storage is generally used to describe a storage system that is somehow "smarter" than just a pile of raw disks. For example, scale-out storage systems might be called software-defined because they virtualize multiple storage nodes into a single virtual disk or file space. Similarly, a storage array that executes automatic migration across performance tiers has been described as software-defined storage.

Storage managers should be cautious of vendors who refer frequently to software-defined storage without really defining what they mean.

Tape Is Still Viable

Tape storage will never go away. In fact, tape remains a valuable Tier 4 tool for storage managers everywhere. Tapes have significant characteristics that haven't changed over the years:

- They are an inexpensive way to store massive amounts of data.
- They can be easily transported from site to site for major disaster recovery purposes and moderate-term archiving.
- When used properly, they can also provide long-term retention of large volumes of data.

The use of tape for enterprise backup is on the wane as disk arrays backing virtual tape libraries (VTLs) have come to market with only a small price premium over high-capacity linear tape open (LTO) drives. Few storage managers prefer to use tape for backup if they can do disk-to-disk, whether direct to a disk file system or to a VTL.

However, the overlapping maze of regulatory regimes requiring long-term storage of very large data sets remains in place. Tape drives and large robotic libraries are especially appropriate for grow-forever and keep-forever data sets such as log files and transaction journals. Making use of tape for such purposes also frees up space on Tier 1 and Tier 2 storage arrays.

Recommendations for Storage Supremacy

Storage often receives less budget attention than other IT areas. To help, organizations should be doing more to manage their storage through appropriate governance. Instead, many prefer to buy more disks rather than deal with the growing pile of data.

Similarly, storage managers who spend their days looking at capacity and performance issues and mitigating risk are not doing enough to deal with the growing problem of too much data in too many places. Consider the following:

1) Storage managers must get out of their offices and focus on organizational strategy to be sure that storage projects are aligned with the organization's direction. Disruptive changes in organizational strategy will require similar changes in infrastructure.

2) Technology is changing in the world of storage. It's not just big enterprise arrays from a small pool of vendors — low-cost arrays from new vendors, scale-out systems, open-source and SSDs are all bringing new tools to meet enterprise needs. Storage managers should review their vendor lineup and be sure they're buying the right products from the right companies.

3) Virtualization isn't a buzzword; it's now a way of doing business. Yet many storage managers went forward with virtualization initiatives without properly designing the underlying storage infrastructure. Now is the time to step back and re-evaluate whether the storage systems, backup procedures, and business continuity plans are all in sync with virtualization's different storage demands.

4) Tiered storage is still tiered storage, but new high-performance Tier 1 systems are available. Storage managers should be looking at SSDs and high-capacity SATA drives for their Tier 1 and Tier 2 requirements.

5) Tier 3 storage is less expensive than ever, and can be used for more than compliance and e-discovery. Storage managers should evaluate their Tier 3 storage systems and look for opportunities to move archive data off of expensive Tier 1 and Tier 2 systems.

CDW: A Storage Partner That Gets IT

The enterprise has experienced massive growth in data storage needs. Furthermore, this trend shows no signs of abating. Adding to this challenge is a need for many organizations to store their data for longer periods and the reluctance to permanently delete anything.

The way to deal with these compounding challenges is to implement a comprehensive effort to optimize an organization's storage infrastructure. That's where CDW comes in with a range of vendor partners, IT products and industry expertise to meet your needs.

An effective data storage solution can consist of one or more of the following components: storage area networks, blade servers, storage management software, archiving software, e-discovery software, data deduplication and data storage virtualization. CDW provides them all.

In addition to storage products that can fit an organization of nearly any size, with any mission, CDW has account managers and solution architects ready to assist with every phase of choosing and leveraging the right storage solution for your IT environment. Our approach includes:

- An initial discovery session to understand your goals, requirements and budget
- An assessment review of your existing environment and definition of project requirements
- Detailed manufacturer evaluations, recommendation, future environment design and proof of concept
- Procurement, configuration and deployment of the final solution
- Telephone support as well as product lifecycle support

To learn more about CDW's storage solutions, contact your CDW account manager, call 800.800.4239 or visit CDW.com/storagemanagement

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