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DATA CENTER CONVERGENCE

Harnessing infrastructure for maximum benefit

Executive Summary

When islands of data center technology, such as servers or storage area networks, are aligned with specific applications or organizational departments, the result is often inefficiency. IT departments end up with applications that underutilize or waste the resources allotted to them, or applications that are starved of the resources they need.

Through a process of data center convergence, organizations can better manage their IT resources and ensure optimal performance of mission-critical applications. By moving to a converged data center, organizations can help eliminate complexity and waste, resulting in strong cost savings. They can also help support growth and improve reliability, availability and serviceability, as well as quality of service (QoS). An additional benefit of convergence is that organizations can increase agility and flexibility to meet and adapt to changing conditions.

Consolidation is a foundational element of a converged data center. So are optimizing how applications are delivered and enabling resource provisioning. Taken all together, this means a converged data center can help the enterprise deliver the right balance of performance, availability, capacity and functionality in an economical, effective manner.

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Server Consolidation and Virtualization

Migrating to a converged data center involves moving from silos of technology toward a consolidated, scalable, multitenant model. The first step is to leverage server virtualization to help reduce cost and improve server-resource utilization. Virtualization offers agility and flexibility, which in turn enables server consolidation, resource sharing, reduced complexity and enhanced business continuity and disaster recovery.

In many organizations (particularly those that have not yet begun their journey to a more efficient and productive IT environment), computer servers are dedicated to specific applications. As a result, some servers are not fully utilized and the enterprise is missing an opportunity to use those resources for additional work. Moreover, an underutilized application server means the organization is actually spending more than necessary to host the application.

At the same time, when it comes to overutilized servers, other applications suffer poor performance that results in lost productivity.

The Components of Convergence

- Server and desktop virtualization for consolidation and agility
- Blade servers to support increased compute density demands
- Network optimization for local- and wide-area data movement
- Storage virtualization and optimization
- Converged infrastructure solutions to remove management complexity
- Converged data center reference architectures
- Converged data center management tools and process

In a converged data center, applications are decoupled from physical servers and assigned to pooled, applicable resources. The resources might be on a shared server where other applications coexist in a multitenant environment, logically isolated from other tenants.

Instead of having, for example, five application servers, each with its own physical machine or server — only 15 percent of which is utilized (CPU, memory or I/O) — IT can employ server consolidation and virtualization to aggregate those five servers. In the process of aggregation, the operating system, its applications and associated data go through a physical-to-virtual (P2V) transformation.

The result is a virtual machine (VM) that can coexist with other VMs on the same, shared physical machine, all logically isolated and secure from each other. In this consolidation scenario, instead of five physical machines (servers), there is one (or perhaps two for high availability and redundancy) with five virtual machines running on it.

The resulting virtualized server now runs at a higher utilization rate, and the five VMs and their applications improve overall performance and QoS and help IT meet general service-level objectives. Because fewer physical servers are required, IT can cut back on floor and cabinet space, power and cooling and associated server management, all of which help lower capital and operating costs.

Server consolidation and virtualization have other IT benefits, including application mobility, whereby virtual machines and the applications they run can move in and out of hardware resources as needed. The next wave of server virtualization expands IT's focus from how many VMs can be put on a physical machine to reduce cost, to how the VMs can leverage faster servers and open up new opportunities.

For example, by using different best practices, a SQL Server database (or any other time- and/or performance-sensitive application) can be given its own physical machine during busy periods. But during off-hours, other VMs can be moved onto the same physical machine in order to make more efficient, round-the-clock use of the premium server resource.

As a result, time- and/or performance-sensitive applications get the resources they need without being impacted by

Server Virtualization Benefits

- Consolidate underutilized resources to reduce waste
- Eliminate pockets or islands of dedicated technologies
- Move legacy applications or operating systems to newer technology
- Increase effectiveness of newer and faster servers
- Avoid resource shortages or lost productivity for applications
- Enhance high availability, business continuity, disaster recovery and application load balancing
- Ensure faster mean time to provision servers for application use
- Improve energy efficiency and support for other green IT objectives
- Provide a pathway to virtual desktop infrastructure (VDI) initiatives
- Create a stepping stone to public and private cloud computing

others. Meanwhile, during evening hours, in addition to performing nightly maintenance, reporting, business analytics and backup, other VMs benefit from using the faster server. The net result is improved overall utilization of converged data center resources to support business growth and increased productivity.

Server virtualization also offers a pathway to public and private cloud infrastructures by providing a mechanism for encapsulating servers, applications and data. Once encapsulated in a virtual machine, IT can easily move applications into a private or public cloud as needed.

Moreover, by decoupling data from a VM, similar to the way IT can decouple shared storage from physical servers in a traditional data center, virtualization allows greater flexibility in what types of storage the converged data center uses. For example, a VM can be local but point to remote cloud storage. Or a VM can be moved to a cloud and use storage provided by the cloud service.

The Role of Blade Servers

Blade servers have become popular building blocks for enabling converged data centers. They offer the ability to reduce complexity while supporting higher resource densities in terms of compute capacity, memory and I/O for storage and networking. With each successive generation of computer processors, more CPUs or "cores" are packaged into a smaller physical space. In addition to all those cores, new server processors enjoy better performance, measured either in cycle times or the number of instructions they can process per second.

As a newer technology, blade servers help meet the growing demand for more processing capability, memory and I/O in the same or a smaller footprint. Available in various sizes and configurations, blade servers pave the way for aggregating multiple larger, traditional servers in a smaller, denser space. In addition to taking up less room in a data center, they help reduce management complexity and enable modular growth.

Blade servers remove some of the complexity commonly associated with servers because they virtually eliminate cabling for I/O and for expanding storage and networking connectivity. They offer significant flexibility in choosing different storage connectivity options, including shared or dedicated serial-attached SCSI (SAS), Fibre Channel, InfiniBand, and Gigabit and 10-Gigabit Ethernet. The LAN adapters in the blade servers, in addition to other forms of connectivity, also support shared storage over IP, including iSCSI and network-attached storage (NAS) – both Network File System (NFS) and Common Internet File System (CIFS) flavors.

With a blade server system, as greater compute capability is needed, organizations can simply install an additional blade into an open chassis slot. As one blade server chassis fills up, additional chassis can be installed in the same or adjacent cabinets.

Blade Server Amenities

- Improve power, cooling and floor space efficiency ☑
- Support increased density of server compute, memory and I/O ☑
- Reduce the complexity associated with physical management and cabling ☑
- Help adapt server resources to changing business needs ☑
- Provide the ability to expand resources as a business grows ☑
- Complement converged networking, storage and management ☑
- Provide a platform for physical and virtualized applications ☑
- Consolidate servers while physically isolating applications ☑
- Enable I/O consolidation for storage, networking and keyboard/video/mouse (KVM) ☑
- Integrate chassis and server resource management ☑
- Provide an incremental step in migrating to a converged data center ☑

In addition to modularity and flexible growth, blade servers support various CPU and memory configurations, as well as different I/O options. For example, IT staffs can configure some blades for compute-intensive video and business analytics processing, while configuring others with additional memory and I/O to support database, e-mail, Microsoft SharePoint and web applications.

Many applications, including databases and virtualization programs, require large amounts of fast memory. Blade servers support those large memory banks. Keep in mind that simply adding more memory is not enough to adequately run high-performance solutions. The memory also must be fast and low-latency to avoid introducing bottlenecks.

The Importance of Network Optimization

In a converged data center environment, traditional I/O and storage connectivity, along with LAN and data communications, are highly interdependent. In general, the faster a processor or server, the more prone it is to performance issues when waiting for slower I/O operations. As a result, faster servers need better-performing I/O connectivity and networks. Better performing means lower latency, more I/O operations per second (IOPS) and better bandwidth. This higher level of performance is required to keep up with various

operations and application profiles and to avoid bottlenecks and aggravation caused by aggregating data center resources.

Blade servers support traditional LAN and storage connectivity. But they also are prime candidates to leverage converged network adapters (CNAs) that support both legacy Ethernet TCP/IP– and TCP/UDP–based traffic, along with Fibre Channel over Ethernet (FCoE). This means that a single CNA (or, per best practices, a pair for redundancy and performance) provides the same functionality as a traditional Fibre Channel or LAN adapter, reducing cabling complexity while freeing up valuable expansion space within the servers themselves. A single CNA card can support, concurrently, traditional IP functions over Ethernet as well as iSCSI, NAS and Fibre Channel (via FCoE) in order to meet application–specific needs while at the same time implementing QoS and other functionality. CNAs are also flexible because IT can reconfigure them to meet changing needs as blade servers are reprovisioned from physical to virtual support, or for different application requirements.

Moving forward, converged, enhanced Ethernet, supporting FCoE, provides the ability to carry Fibre Channel traffic — including Fibre Channel Protocol (FCP) and Fibre Connectivity (FICON) — via Ethernet while also transporting TCP/IP–based traffic. This differs from current approaches where Fibre Channel traffic can be mapped onto IP using Fibre Channel over IP (FCIP) for long–distance, remote replication. With FCoE, the TCP/IP layer is removed, along with any associated latency or overhead, but only for local usage.

Bandwidth optimization solutions help systems coexist in hybrid environments, enhancing backup or the movement of distributed data and accessing cloud resources. When moving data to or from cloud–based or remote backup services, bandwidth optimization can take the form of data footprint reduction at the source, as well as protocol and network technologies.

Storage Virtualization and Optimization

Servers process data that is moved over networks and kept on data storage systems. And these days, primarily because organizations are retaining more data for longer periods of time, storage needs to be considered part of a converged data center environment.

Virtual and converged environments need shared storage, which IT departments can accomplish using shared serial–attached SCSI for in–cabinet and high–density blade servers. Other options include Ethernet–based iSCSI, NAS (NFS and CIFS), Fibre Channel over Ethernet and traditional Fibre Channel. Multiprotocol and unified storage solutions that support a mix of block (SAS, iSCSI, Fibre Channel and FCoE)

High Availability Rules

Why not use iSCSI? Why the need for Fibre Channel over Ethernet? Why not just use TCP/IP as the converged network? These are common questions.

For some environments, where low cost, ease of use and good performance are the main requirements, iSCSI–based access to storage is a good approach. But for environments that need very low latency, good or very good performance and additional resiliency, Fibre Channel can be the better option.

In addition, bandwidth–optimization techniques have evolved from general–purpose compression to application–specific optimization. Application–specific optimization ranges from protocol–specific solutions, such as Common Internet File System (CIFS), Network File System (NFS) and TCP/IP, to remote replication or data mirroring, remote tape copy and cloud access. Some solutions are focused on maximizing bandwidth, while others are optimized for reducing latency, leveraging caching or other techniques.

For example, environments that are looking to consolidate servers and storage resources away from remote office branch locations will want to consider bandwidth optimization options such as wide–area application services (WAAS), wavelength add/drop multiplexer (WADM) and wide–area file services (WAFS) from vendors such as Cisco Systems, Riverbed Technology and others.

Storage Virtualization Functionality

- Pooling or aggregation of storage capacity ☑
- Dynamic provisioning and allocation of storage ☑
- Transparency or abstraction of underlying technologies ☑
- Agility and flexibility for load balancing and storage tiering ☑
- Automated data movement or migration for upgrades or consolidation ☑
- Heterogeneous snapshots and replication on a local– or wide–area basis ☑
- Thin and dynamic provisioning across storage tiers ☑
- Data footprint reduction for space optimization ☑
- Improved management reporting and metrics for insight and awareness ☑
- Application programming interfaces for application integration and simplified management ☑
- Enhanced performance for storage optimization ☑

and file (NAS, NFS, CIFS) operations have become popular for converged environments.

Multiprotocol storage systems combine traditional block- and file-based storage into a unified solution in order to reduce cost and complexity while adding flexibility, resiliency and scalability. In a converged environment, shared storage is important because it allows different physical servers to access storage resources so they can support the various applications they host.

The same way that virtual servers eliminate the dependency or affinity of a given application to a specific server, shared storage enables the hosting of VMs, their applications and their data because the actual storage is not confined to a dedicated system or server.

As IT organizations know, at a time when dependencies on information continue to grow, there is no such thing as a data recession. Addressing data growth and associated infrastructure resource management (IRM) and data center infrastructure management (DCIM) tasks — along with other data protection costs — can be as simple as preventing certain data from being stored at all. Data footprint reduction (DFR) comprises a set of techniques, technologies and best practices that help drive efficiencies so that more can be accomplished with available resources.

Reducing an organization's data footprint has many benefits, including reducing or maximizing its IT infrastructure resources, such as power and cooling, storage capacity, and network bandwidth, while at the same time enhancing application-service delivery in the form of timely backup, business continuity/disaster recovery, performance and availability.

If an organization does not already have a DFR strategy, now is the time to develop and implement one across its environment. There are many different DFR technologies for addressing various storage-capacity optimization needs, some of which are time/performance-centric while others are space/capacity-focused. Different approaches use different metrics to gauge efficiency and effectiveness.

Data Footprint Reduction Techniques

- Archiving (structured database, e-mail, unstructured big data and file data) ✓
- Compression and compaction, including real-time or time-deferred compression ✓
- Data management, including cleanup and deletion of unnecessary data ✓
- Data deduplication, including source, target, in-line and post processing ✓
- Network optimization for bandwidth, latency and distance ✓
- Space-saving snapshots, thin provisioning and dynamic allocation ✓

Which DFR technique is the best? That depends on what IT is trying to accomplish in terms of business and IT objectives. For example, is the goal to achieve maximum storage capacity at the lowest cost without concern for performance? Or does the enterprise need a mix of performance and capacity optimization? Is the IT staff looking to apply DFR to primary, online, active data and applications, or to secondary, near-line, inactive or offline data?

Some forms of storage optimization reduce the amount of data and/or maximize available storage capacity. Other forms of storage optimization focus on boosting performance or increasing productivity.

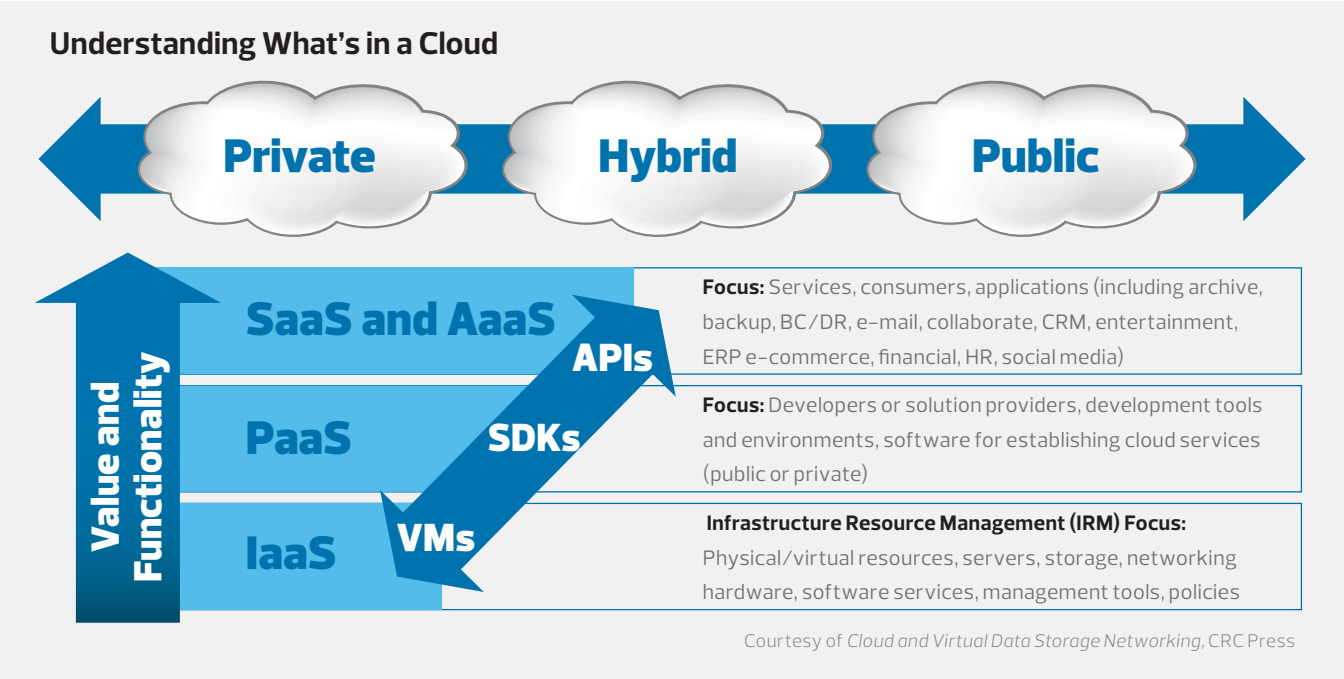
In short, data footprint reduction is expanding beyond just deduplication for backup and other early-deployment scenarios. For some applications, reduction ratios are an important focus, so organizations need tools and techniques that deliver those results. Likewise, for applications that require performance first with some data-reduction benefit, there are tools that are optimized to meet those priorities. Vendors have begun to expand their current capabilities and techniques to meet changing needs and criteria. Those with multiple DFR tools will better meet an organization's needs than those that offer just a single DFR function or focused tool.

Clouds and Converged Infrastructure Solutions

Perhaps one of today's most high-profile manifestations of a converged infrastructure is the cloud. Cloud computing goes by different definitions, depending on whom you talk to. Those definitions may, in turn, be influenced by what people have heard, seen, read or experienced of the technology.

For many, cloud computing is an IT management and operating philosophy or paradigm. Clouds can represent an architecture, product or service — offered free or for a fee — that can be delivered on premises, remotely or via a combination of approaches. Clouds can be public or private, or a hybrid of the two, combining services and products. And they can function as a replacement for traditional IT or as a complement to enable new functionality.

The illustration on the following page shows what people talk about in regard to cloud resources. It uses the nomenclature of infrastructure as a service (IaaS), which includes cloud-based server, storage, networking and I/O resources; platform as a service (PaaS), also known as middleware, which provides environments for developing and deploying applications that run on a public or private IaaS; and application as a service (AaaS) or software as a service (SaaS), which represent the actual cloud-based productivity and other programs that IT may deliver to end users.



Courtesy of *Cloud and Virtual Data Storage Networking*, CRC Press

Private clouds are similar to public clouds except that they are intended to be used by a single organization. A private cloud can be built and located entirely internally, or it can leverage external, public resources. The line between a private cloud and a traditional IT infrastructure can be blurry depending on different definitions or solution offerings. Many of the same tools and technologies — from hardware and software to networking — are used for both public and private clouds, as well as for traditional IT environments.

A private cloud extends to organizations the same operating principals of a public cloud — agility, elasticity, effective resource usage and metering for management insight — but it also offers more control. A private cloud can evolve to support chargeback or billing, where applicable, as well as self-provisioning or resource procurement by consumers of information services.

Converged Infrastructure Solutions and Stacks

Whether an organization is interested solely in a converged data center or it also wants to set the foundation for cloud computing, there are all-in-one solutions — or stacks — that can help it accomplish its goal.

Preconfigured data center solutions — with servers, storage, networks and associated cabling, power and cooling integrated at the factory — have existed for years. The main differences among existing preintegrated solutions, which have various marketing names (including "data center in a box"), are density and scale. Existing solutions are typically based on a preintegrated cabinet or series of cabinets ready for rapid installation at a customer's site.

The biggest advantage of the bundle approach is that it helps remove some of the cost and complexity associated with moving to a new data center paradigm. Bundled solutions help jump-start efforts to move to a flexible converged or virtual environment with a ready-to-deploy solution. The cost savings can derive from ease of acquisition, installation and/or configuration. And if the solution comes with the right tools, organizations can realize even more savings if the tools enable automated provisioning.

Cloud and converged infrastructure solution stacks come in several variations, from loose multivendor marketing alliances to integrated, tested and interoperable technology reference architectures. These stacks can include products from the same or different vendors, purchased separately or under the same SKU number. The value proposition of stacks and solution bundles is straightforward: ease of acquisition, deployment and interoperability.

Converged solution stacks can exist on an organization's premises or at a collocation or hosting site. They typically include servers, network connectivity, storage and associated management tools. In addition, solution stacks are available with options for hypervisors to support virtual machines, such as those from Citrix, Microsoft (Hyper-V) and VMware (vSphere), as well as traditional operating system/physical machine-based modes.

These converged solution bundles also support specific databases, such as Oracle and Microsoft SQL Server, and enterprise applications, such as SAP, Microsoft SharePoint and Exchange, and others.

One example of a converged infrastructure solution is VCE Vblock, which combines Cisco Unified Computing System (UCS) servers with EMC storage and management tools and support for Microsoft Hyper-V and VMware vSphere.

Another example is NetApp FlexPod, also based on Cisco UCS servers, but combined with NetApp storage systems and associated management software tools. HP (CloudSystem and VirtualSystem) and IBM (BladeCenter Foundation) also offer converged solutions, based on their own servers and storage, along with various networking options and management tools.

Reference Architectures: Cookbooks for Success

In addition to converged infrastructure solutions, various vendors and solution providers offer reference architectures, which are basically blueprints or frameworks for deploying converged environments. These blueprints provide information and associated best practices for addressing different application and deployment scenarios, based on the specific technology in the reference architecture.

Converged reference architectures are like cookbooks, with specifics on how, when and where to deploy various solutions. They usually offer best practices for ongoing management chores, including data protection. Like solution stacks, reference architectures can reduce the time and complexity involved in deploying converged data center solutions by eliminating the guesswork of integrating technologies. In doing so, a good reference architecture can help an organization maximize the return on investment from converged solutions.

Another reason to use reference architectures is to identify solution candidates to address an organization's unique objectives. Some reference architectures show how to deploy various a la carte technologies from different vendors (servers, storage, networking and software management tools) to support middleware or application platforms. For example, if an organization is looking to implement a converged server and networking infrastructure environment, reference architectures for VMware vSphere, Microsoft Hyper-V and Citrix, tied to different hardware platform solutions, should be required reading. Other reference architectures show how to deploy bundled-stack solutions, including installation, ongoing management and data protection, among other best practices.

Converged Data Center Management

When it comes to managing a converged data center, software and management tools are interwoven with hardware, services and best practices in a transparent manner. Instead of separating hardware, software and tools, they must be blended because in a converged data center, you cannot have hardware without software — and vice versa. Virtualization and cloud services rely on underlying physical resources, tools, people and best practices.

Management tools address an important IT requirement in a converged data center environment: the need for situational awareness of IT resources. This means having insight into how IT resources are being deployed in order to support business applications and meet service objectives in a cost-effective manner.

Data Center Management Tools Can Monitor:

- Physical, virtual, converged and cloud resources ☑
- Servers, storage, VDI, networking hardware devices and software ☑
- Application, middleware and IRM/data center infrastructure management ☑
- Operating systems and hypervisors ☑
- Facilities, energy, power, cooling plus heating ventilation and air conditioning ☑

Awareness of IT resource utilization provides the necessary insight for tactical and strategic planning and decision-making. Put another way, effective management requires knowing not only what resources are at hand, but also how they are being used in order to decide where in the environment different applications and data should be placed to meet business requirements.

Another important capability of converged data center management is visibility into common tasks, such as disaster recovery and data protection management (DPM), resource tracking, change management, and performance-capacity planning. The tools organizations use should provide the situational awareness for identifying resource allocation and utilization while providing insight into physical resource mappings in dynamic environments.

In addition, the right tools should enable coordinated workflow management, including workflow generation. Related to that, the workflow management function should help identify areas of the infrastructure in need of configuration change or remediation and streamline data and storage migration activities.

Leveraging converged technology means managing resources differently. Instead of managing the physical box, cable or adapter, organizations must learn to manage the processes, protocols, procedures and policies. Moving to a converged infrastructure for cloud-based, virtual or physical data center environments means also moving to a model of converged or unified management.

Hybrid teams of professionals with server, storage, networking and software experience can identity procedural bottlenecks. Bottlenecks may be the result of a "that's how it's been done in the past" mindset toward a particular technology area. For example, storage area network personnel have traditionally focused on low latency, predictable performance

and service delivery. In a converged data center, priorities can change, depending on the application or service, thanks to the virtualized nature of the underlying infrastructure.

CDW: A Data Center Convergence Partner That Gets IT

Transforming an IT environment into a converged data center infrastructure enables agility, flexibility and improved resource effectiveness. The most significant result is less complexity, which can translate to lower costs and higher productivity.

By moving away from islands of technology, organizations that adopt a converged data center can streamline information services delivery while enhancing quality of service and meeting service-level objectives. Ultimately, converged data centers can support growth while maintaining or enhancing customer service within constrained or shrinking IT budgets.

Take the next step toward a converged data center: Contact CDW for a consultation with a certified data center solution architect.

Because of its partnerships with literally thousands of technology manufacturers and service providers, CDW can sell convergence solutions as completely integrated IT offerings — even though they consist of multiple technologies such as large core switches, blade servers, hypervisor and other virtualization software, and network-attached storage.

To help determine a strategy that can take advantage of tools already installed and how to get the most through convergence, the data center solution architect typically conducts a half-day workshop to discuss optimization technologies and best practices; to gather details about facilities application delivery methods and requirements, disaster recovery and continuity requirements, standards compliance and IT governance; to identify current challenges to providing quality IT services; and to begin developing a full-blown data center convergence strategy.

To learn more about various converged infrastructure topics, technologies, techniques and best practices, call 800.800.4239 or visit CDW.com/datacenter

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While virtualization in general can bring you many advantages, VMware virtualization solutions are built on a robust foundation proven in production environments and chosen by over 250,000 customers, including the Fortune 100. Built on VMware vSphere, the industry's most advanced virtualization platform, we enable solutions from the desktop to the data center, utilizing existing IT investments. Our solutions can be integrated with your overall IT infrastructure and existing management tools. If that's not enough, we also have the lowest total cost of ownership.

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