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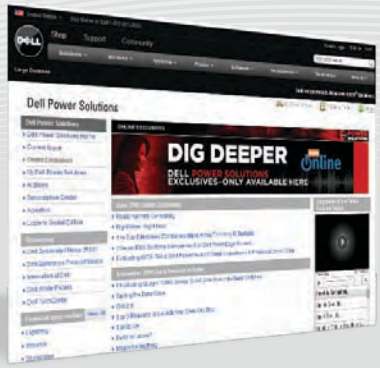
MAKING A SUCCESSFUL TRANSITION TO A GREEN IT INFRASTRUCTURE

By Albert Esser, Ph.D.

Adopting a green IT infrastructure is the key to sustainable growth, and in today's economic climate can often be the difference between simply surviving and flourishing. CIOs can accelerate this transition by cost-justifying strategic IT investments that advance enterprise efficiency while helping to simplify management and reduce operational costs—thereby contributing to a healthy bottom line and a healthy environment.



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Power Cap Control in Dell PowerEdge M1000e Modular Blade Enclosures

By Brian Bassett and Shonn Burton

The power cap options for Dell PowerEdge™ M1000e modular blade enclosures and PowerEdge M-Series blade servers offer administrators flexible control over power allocations in their data centers.

STORAGE

iSCSI Best Practices: Choosing Between Software and Hardware Initiators

By Ujjwal Rajbhandari and Dan McConnell

Internet SCSI (iSCSI) software initiators can provide levels of throughput and efficiency comparable to hardware initiators for most types of applications—offering a cost-effective way to implement iSCSI without the need to invest in additional hardware components.

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By Sean Glynn

Sensitive information stored on mobile devices may be subject to a host of data security laws and other requirements. Encryption can help seamlessly protect this data—and keep your company out of court.

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December 2009

7 WORDS ON WINDOWS 7

Tom Kolnowski
Editor-in-Chief and Publisher
tom_kolnowski@DELL.COM
DELL.COM/PowerSolutions
powersolutionsdigital.dell.com

With the advent of the Microsoft® Windows® 7 OS, IT organizations face myriad decision points. If you had elected to bypass the Windows Vista® OS entirely and remained on Windows XP Professional, the key questions are likely around when and how to initiate a migration. For organizations with a mix of Windows Vista and Windows XP, is it time to consolidate to Windows 7? Is this an occasion to accelerate your client refresh cycle, including Windows 7 images on the new systems? Should you examine the latest approaches to desktop virtualization for an increasingly mobile workforce? And how do you most efficiently deploy, manage, and support Windows 7?

Beginning with this issue, we plan to bring you straightforward guidance on many of these questions—starting with these seven words on Windows 7:

1. **Plan:** Our special section on the Windows 7 and Windows Server® 2008 R2 operating systems begins on page 8. The lead story, "5 Steps for a Successful Windows 7 Enterprise Deployment," offers guidance on how to approach your migration.
2. **Integrate:** On page 11, "Top 10 Enterprise Features in Windows 7" describes new capabilities in the OS designed to meet the evolving needs of IT users and IT professionals alike.
3. **DirectAccess:** On page 16, learn about an alternative to traditional VPNs for Windows 7 clients in "Seamless Connectivity: Introducing Microsoft Windows Server 2008 R2 DirectAccess."
4. **BranchCache:** On page 22, "Enhancing WAN Performance with Microsoft Windows Server 2008 R2 BranchCache" articulates how networking enhancements can be delivered for Windows 7 users in branch office locations.
5. **Virtualize:** On page 25, approaches to desktop virtualization are discussed in "Virtual Desktop Infrastructure in Microsoft Windows Server 2008 R2."

6 and 7. Special Edition: Beyond this issue, there is much more to come. Our editorial staff is working with best-in-class IT professionals, engineers, and ISVs to deliver the *Dell Power Solutions Windows 7 Migration Guide*—a separate 52-page Special Edition dedicated to Windows 7 migration coming in the first quarter of 2010. You will also be able to access a digital version of this guide at DELL.COM/PowerSolutions.

In addition, we are pleased to bring you our annual feature section on green IT (starting on page 30), headlined by "Efficient Enterprise: Making a Successful Transition to a Green IT Infrastructure"—a CIO-centric perspective on sustaining growth while contributing to a healthy bottom line. We hope this and the other four articles in the section help you achieve your green IT goals.

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5 STEPS FOR A SUCCESSFUL WINDOWS 7 ENTERPRISE DEPLOYMENT

A comprehensive readiness assessment can help you discover whether your organization is prepared for migration to the Microsoft® Windows® 7 Enterprise OS—and what you need to do beforehand to help ensure a successful deployment.

The first step in virtually any OS migration is to understand your starting point. However, with thousands of desktops, laptops, and mobile devices to track and maintain, large enterprise IT departments do not always have a complete picture of which operating systems and applications employees and key contractors are using. To make matters worse, few enterprises are currently leveraging automation technologies to manage and maintain client computing environments efficiently.

Although IT administrators typically operate in hybrid environments with some level of automation, they also continue to rely largely on manual intervention. Unfortunately, without a comprehensive understanding of the assets already in use throughout the enterprise, IT organizations often cannot leverage automation to best advantage and reap the benefits of migrating to Microsoft Windows 7 Enterprise—the version of Windows that is specifically architected for business users.

Migrations are often logistically complex. How can IT strategists help ensure a successful Windows 7 Enterprise deployment? The process of coordinating equipment shipments, managing on-site technicians, and scheduling users can be cumbersome and time-consuming. However, advance planning and preparation helps to dramatically reduce labor and associated deployment expenses.

In particular, proper preparation enables IT teams to optimize deployments and avoid costly mistakes. In addition, planning ahead can help to facilitate multitasking, minimize network traffic, maximize logistical flexibility, reduce infrastructure dependencies, and accommodate out-of-band deployments for remote users.

Five key steps can help ensure a smooth transition to Windows 7 Enterprise:

1. **Evaluate the readiness of the organization and of end users:** Determining readiness to migrate to Windows 7 Enterprise starts with understanding the way workers in your enterprise are currently using their computers. Because unprepared employees are likely to bombard your support centers with questions, end users must be properly briefed before making the switch from their current desktop environments to Windows 7 Enterprise. Proper advance notification and training can help to minimize IT support calls and avoid interrupting business productivity.

   Gap analysis is typically the best way to determine how to announce the migration and give employees the training they may need to use Windows 7 Enterprise effectively. Take stock of how workers feel about their current OS, identify needs that are not currently being met, and communicate the advantages of Windows 7 Enterprise in terms of new capabilities that can help increase productivity and efficiency.
2. **Determine hardware compatibility:** Windows 7 Enterprise requires certain hardware features to run—features that are available in current Dell™ OptiPlex™ desktops, Dell Latitude™ laptops, and Dell Precision™ workstations.

> **"By formulating and following a well-designed deployment strategy, enterprise IT leaders can create an optimized, scalable, automated process that is repeatable throughout the organization."**

ASSISTED MIGRATION: DELL PROCONSULT, PROMANAGE, AND PROSUPPORT SERVICES

By automating many of the tasks involved in a Windows 7 migration, Dell can help to dramatically simplify the process. Each consulting engagement begins with an assessment of your environment's preparedness to migrate to Windows 7 Enterprise. Assessment services can include reviews of hardware, image, and application compatibility with Windows 7. The assessment can also evaluate IT staff and end-user skill sets as well as potential training requirements. Using the results of this assessment, the Dell team works with each IT organization to design an implementation plan to help minimize impact on end users and on the server and network infrastructure, and to provide appropriate training to IT support teams. For more information, visit DELL.COM/Services.

However, for organizations that choose to maintain legacy systems, ensuring that all hardware platforms meet these prerequisites can help avert headaches during the migration process. Start by taking a comprehensive inventory of the desktops, laptops, and mobile devices workers are using. Next, create a return-on-investment business case for improving quality of work and lowering costs for client system deployments. Address bottom-line considerations by explaining how the strategic investment in capital equipment can both advance business goals and save on operating expenses. When necessary, refresh client systems—perform user-specific automated image and application configuration, migrate data and settings, and update any outdated drivers on end-user devices.

3. **Assess business application readiness and compatibility:** Migrating to Windows 7 Enterprise may cause some applications to work differently than users expect. By flagging potential issues ahead of the migration, you can update or replace applications if necessary to avoid these problems.

   Begin by conducting a comprehensive survey of the applications in use throughout the organization. Create reporting mechanisms that identify applications incompatible with Windows 7 Enterprise to help prevent problems and avoid rework later in the migration process. If any redundant applications exist, remove them to help streamline IT administration—then standardize application selections and versions to help simplify future deployments and maintenance for IT staff. Prioritize applications for compatibility assessments and possible remediation.

   Once the list of applications has been finalized, gather requirements for each packaged application (including source, installation instructions, technical dependencies, and test scripts). Then perform user acceptance testing for packaged applications to help ensure that user productivity will not be impaired following the deployment.

4. **Lay the technology foundation for new features:** Some Windows 7 Enterprise features that IT administrators may find most valuable require additional supporting technologies in the data center. Organizations can prepare to get the most out of Windows 7 Enterprise by upgrading to the Microsoft Windows Server® 2008 R2 OS—which is required, for example, to support the Microsoft BranchCache™ and DirectAccess features. In addition, Windows Server 2008 R2 is designed to facilitate advanced server and desktop virtualization, enhance power management, and support unprecedented workload size, dynamic scalability, and across-the-board availability and reliability. IT departments can further lay the groundwork for Windows 7 Enterprise by implementing IP version 6 (IPv6) and IP Security (IPsec), which provide key support for the DirectAccess feature.

5. **Create a deployment strategy:** By formulating and following a well-designed deployment strategy, enterprise IT leaders can create an optimized, scalable, automated process that is repeatable throughout the organization.

   The first step to creating a solid deployment strategy is to consolidate the installed application base as much as possible. This effort helps reduce complexity, simplify administration, and enhance IT efficiency before the deployment. Next, test deployment procedures thoroughly in a controlled environment to help work out kinks in advance. Finally, have a support strategy in place for any unexpected issues that may arise.

Successfully deploying Windows 7 Enterprise depends on making proper preparations. By determining your company's readiness to migrate ahead of time, you can anticipate potential pitfalls and avoid rework later in the migration process. A well-designed deployment strategy provides a framework for an optimized, scalable, automated deployment process that is repeatable throughout the organization—and these five steps pave the way.

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TOP 10 ENTERPRISE FEATURES IN WINDOWS 7

The Microsoft® Windows® 7 Enterprise OS is designed to meet the evolving needs of users and IT professionals alike. Explore the top 10 features that will also make CIOs smile.

Desktop operating systems are geared toward making life easy for end users—and Microsoft Windows 7 is no exception. Performing everyday tasks and working on new projects is designed to be more intuitive than with any previous Windows system. The Windows 7 OS is also designed to be fast, reliable, and more secure than the Windows XP and Windows Vista® operating systems. Most importantly, productivity enhancements help remove barriers that prevent access to information, regardless of where the data is stored.

At the same time, the Windows 7 Enterprise platform helps simplify management by making it easy for IT organizations to meet diverse client requirements. It offers enhanced security and control by building on the security foundation of Windows Vista, and delivers additional flexibility for IT teams charged with securing desktop and mobile client systems and data. In addition, because administrators can often leverage the same tools and skills they use with Windows Vista for Windows 7 Enterprise desktops, laptops, and virtualized environments, the transition requires minimal training—freeing IT staff to focus on strategic projects.

Ten key features of Windows 7 Enterprise work in conjunction with the Microsoft Windows Server® 2008 R2 OS to advance enterprise efficiency:

1. **DirectAccess connectivity:** As the workforce becomes increasingly mobile and many employees work remotely at least part of the time, the question of productivity becomes increasingly critical. To be as productive as they could be in the office, workers must be able to connect to enterprise resources seamlessly and securely.

   The DirectAccess feature enables mobile users to access enterprise resources simply and securely when out of the office—without the extra step of initiating a virtual private network (VPN) connection. This capability helps to simplify IT management by allowing for an "always managed" infrastructure, which helps ensure that client systems used by mobile workers remain healthy and updated.[1]
2. **BranchCache™ local caching:** For large enterprises with several branch offices and centralized applications, low network responsiveness and slow connection speeds can create significant bottlenecks that hamper productivity and lead to a subpar user experience. The BranchCache feature helps address this issue by caching content from remote file and Web servers at the local branch office, which allows branch office users to access important information quickly. It supports commonly used network protocols to reduce the need for additional IT training. In addition, the BranchCache feature supports network security protocols such as Secure Sockets Layer (SSL) and IP Security (IPsec), helping to ensure that only authorized clients can access requested data. It also helps to reduce wide area network (WAN) traffic, boost network application

[1] For more information, see "Seamless Connectivity: Introducing Microsoft Windows Server 2008 R2 DirectAccess," by Steven Grigsby and Gong Wang, in *Dell Power Solutions*, December 2009, DELL.COM/Downloads/Global/Power/ps4q09-20090443-Grigsby.pdf.

responsiveness, and increase efficiency for end users accessing the content.[2]

3. **AppLocker™ application control:** For enterprises that demand the highest levels of compliance, administrators can leverage the AppLocker feature to dictate which applications are allowed to run on desktop and mobile client systems. This feature provides a flexible, easy-to-administer mechanism that allows IT organizations to exercise control over the infrastructure while also giving workers the ability to run the applications, installation programs, and scripts that they require to be productive. As a result, enterprises can enforce application standardization while also enhancing security and streamlining compliance.
4. **BitLocker™ security:** Because mobile workers often take sensitive information with them on their laptops when they leave the office, encrypting hard drives and removable storage devices can go a long way toward preventing security breaches.

"The Windows 7 Enterprise platform offers enhanced security and control by building on the security foundation of Windows Vista, and delivers additional flexibility for IT teams charged with securing desktop and mobile client systems and data."

The BitLocker feature gives IT administrators and end users the ability to right-click on a drive to enable BitLocker protection (see Figure 1). By supporting automatic creation of the required hidden boot partition, BitLocker advances key management over previous versions of Windows. In addition, the BitLocker To Go™ feature offers data protection for removable storage devices and gives the IT team enhanced control over how removable storage devices can be used.

5. **RemoteApp™ access:** Employees need the same programs when they are working remotely that they use when they are in the office—but installing and maintaining those applications on every laptop can be a serious hurdle for IT staff.

   The RemoteApp feature for Windows 7 Enterprise is designed to enable end users to access the programs they need without actually installing them on the remote computer. Because IT staff can make application updates centrally, this feature helps save administration time and reduce maintenance costs. Updates can then be distributed automatically when users log in.
6. **Multilingual support:** Instead of creating a separate image for each language used in the enterprise,

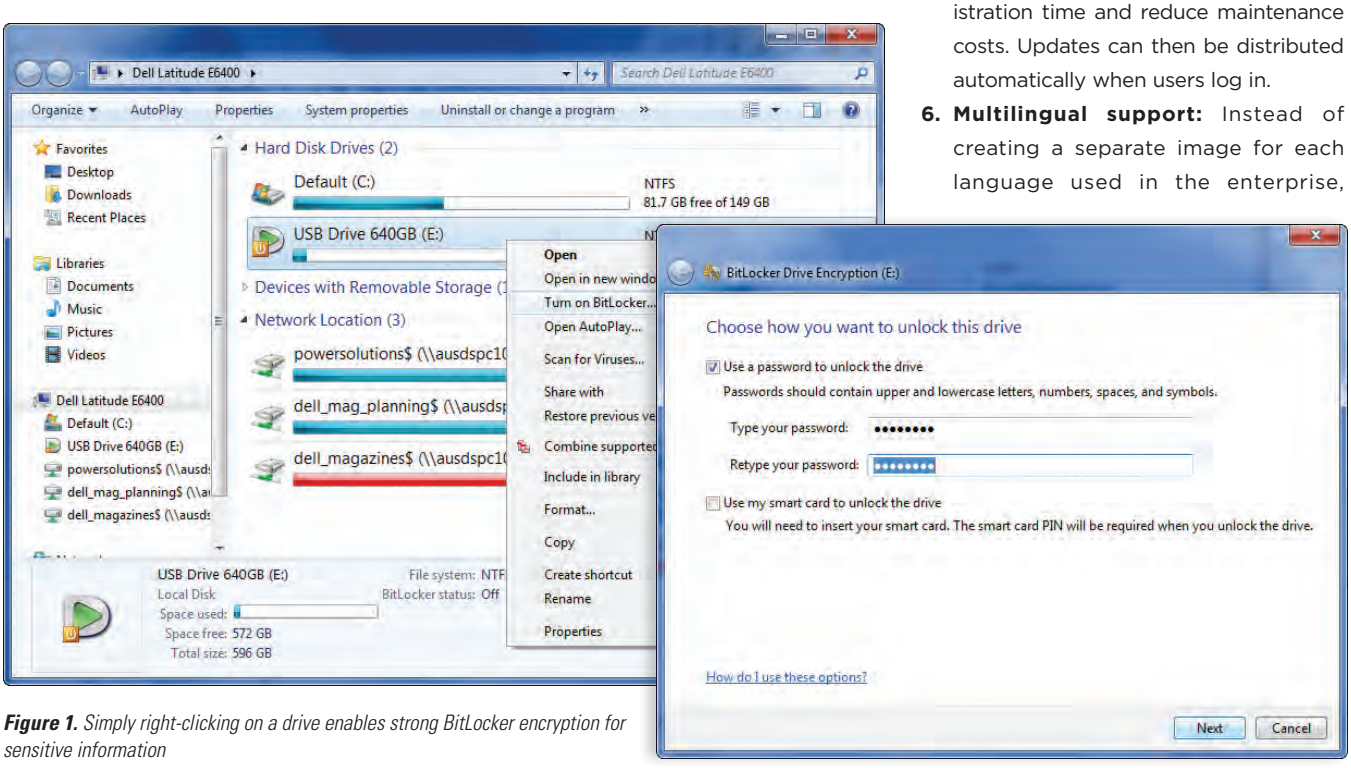

Figure 1. *Simply right-clicking on a drive enables strong BitLocker encryption for sensitive information*

[2] For more information, see "Enhancing WAN Performance with Microsoft Windows Server 2008 R2 BranchCache," by David Waggoner and Joseph Rojas, in *Dell Power Solutions*, December 2009, DELL.COM/Downloads/Global/Power/ps4q09-20100125-Rojas.pdf.

administrators can use Windows 7 Enterprise language packs to support several dozen different languages using a single Windows master image.

7. **Virtual desktop infrastructure (VDI):** Designed to improve end-user productivity while also simplifying desktop administration and security for IT staff, VDI supports desktop functionality using virtual machines hosted on servers. It allows users to access their desktops remotely and to reuse virtual machine images to boot a physical desktop, laptop, or workstation. VDI also helps reduce IT maintenance overhead by centralizing management and avoiding the need to perform patches and upgrades on each physical computer in the enterprise.
8. **Image management:** For organizations that support multiple operating systems and configurations, image management can be a complex, time-consuming, and costly task. But with the Deployment Image Servicing and Management (DISM) tool in Windows 7, IT administrators can build and service OS images using a single consolidated tool set.

   Image management tools built into Windows 7 Enterprise allow administrators to add optional components; add, enumerate, and remove third-party device drivers; add language packs and apply international settings; and maintain an inventory of offline images. Administrators can also use DISM to manage Windows Vista system images, which helps to reduce administrative overhead and costs for mixed deployments.
9. **Power management:** Desktop and mobile computers are responsible for a significant percentage of the power consumption in most enterprises. Because cutting down on energy use can help IT strategists improve the bottom line, Windows 7 Enterprise includes a variety of power management features designed to increase platform and processor efficiencies. For example, Windows 7 helps improve idle efficiency by minimizing resource utilization and enabling processors, disks, memory, and network activity to go into low-power states during extended periods of inactivity. In addition, technologies such as adaptive display brightness and low-power audio help conserve energy and contribute to an efficient, cost-effective enterprise.
10. **Windows PowerShell™ command-line shell:** Used with Windows 7 Enterprise, the Windows PowerShell command-line shell and administrator-focused scripting language can help increase management control and enhance IT productivity. The tool helps simplify management of Windows-based servers, workstations, and applications through an interactive shell, scripting functions, and graphical interface applications (see Figure 2). It offers more than 130 standard command-line tools and utilities as well as a consistent syntax to enable IT teams to accelerate automation easily. It is also designed to work with existing IT infrastructures and existing script investments to facilitate early adoption, learning, and use.

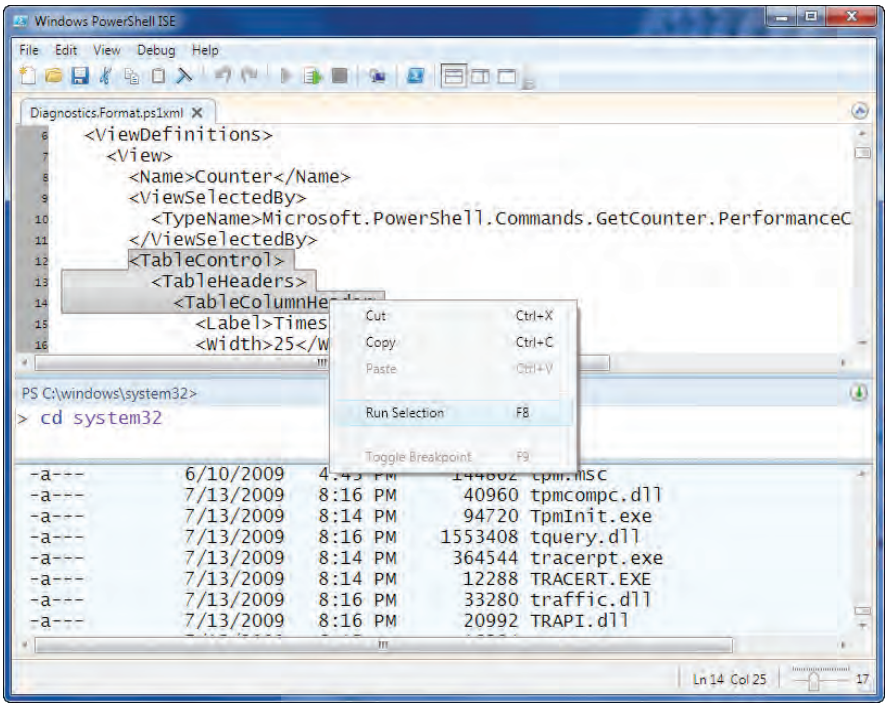

Figure 2. *The Windows PowerShell Interactive Scripting Environment application offers a flexible, intuitive interface for writing, testing, and editing scripts*

In these ways, Windows 7 Enterprise can help significantly boost client security and productivity while simplifying end-to-end IT management and control. For large enterprises intent on advancing business efficiency while reducing total cost of ownership, the question is not whether to migrate to Windows 7—but when.

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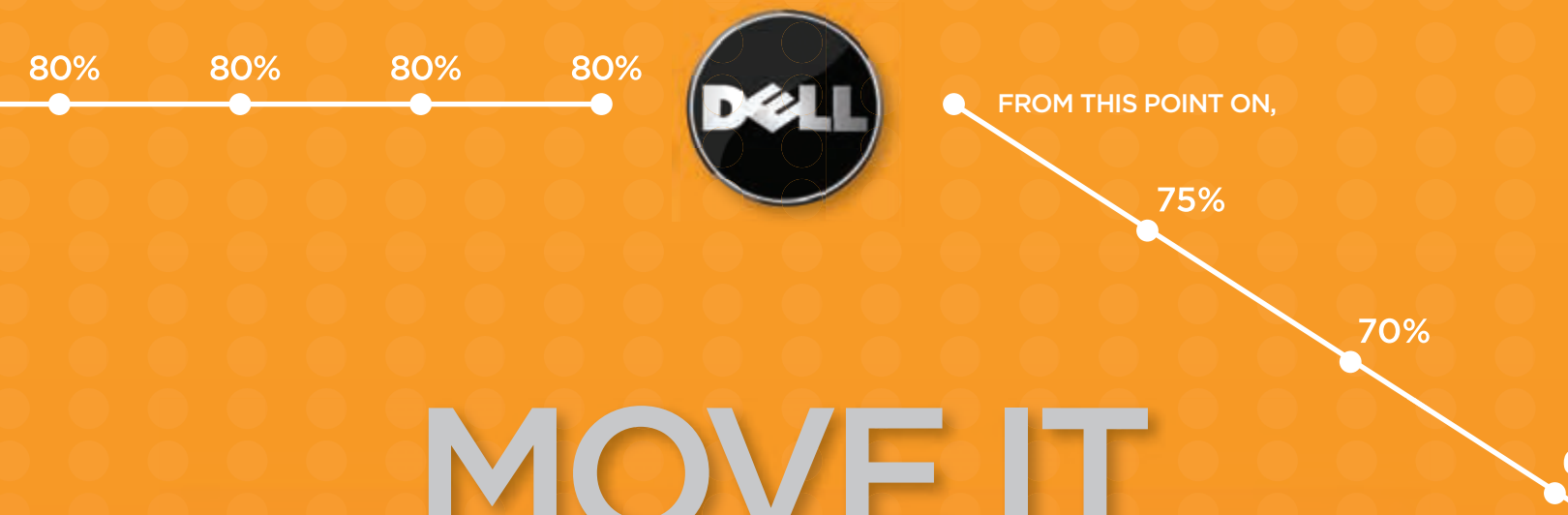

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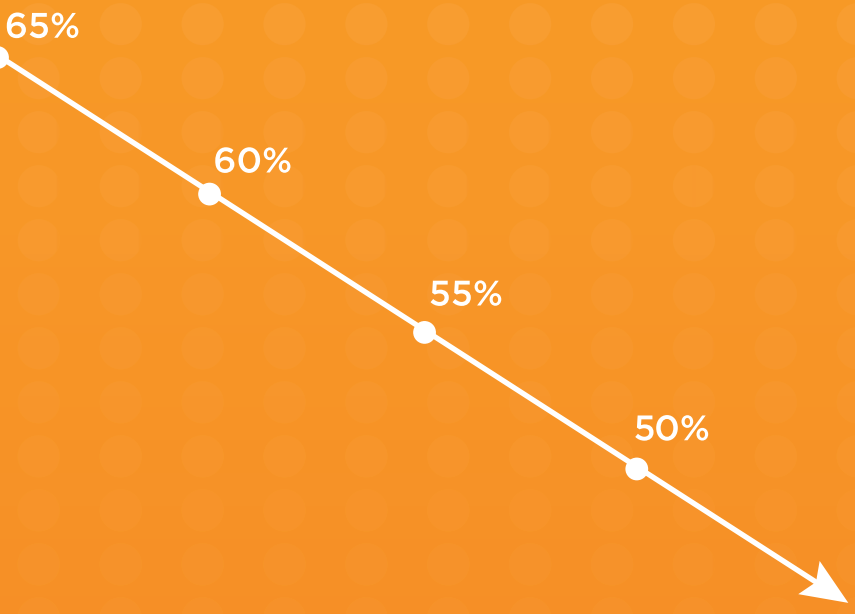

For many large enterprises, IT complexity has driven running costs to as high as 80% of the total IT budget. And instead of focusing on innovation, CIOs struggle to just “keep the lights on.” Time to change course. Partner with Dell to standardize, simplify, and automate so you can cut costs and free up resources to innovate.

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SEAMLESS CONNECTIVITY: INTRODUCING MICROSOFT WINDOWS SERVER 2008 R2 DIRECTACCESS

By Steven Grigsby
Gong Wang

The Microsoft® Windows® 7 and Windows Server® 2008 R2 operating systems introduce DirectAccess, a new feature designed to provide remote users with seamless, secure access to internal enterprise networks. This article describes the technologies underlying DirectAccess as well as best practices to help administrators successfully deploy, monitor, and manage it in their own environments.

Today's enterprise workforce is more mobile than ever, requiring access to intranet resources from a wide range of locations outside the office, not only at home, but also at hotels, airports, coffee shops, and other hotspots all over the world. Although traditional solutions such as virtual private networks (VPNs) and application gateways can offer remote access to intranets and applications, these approaches also come with several disadvantages—and for IT administrators, supporting this type of remote access in a secure, seamless, and manageable way can be difficult.

To help overcome these challenges, the Microsoft Windows 7 and Windows Server 2008 R2 operating systems introduce DirectAccess, a new feature designed to maintain a seamless, secure bidirectional connection between Windows 7–based client systems and enterprise intranets without requiring a VPN connection. By doing so, it can provide remote users with the same experience they would have when they are physically in the office—including comprehensive access to intranet resources such as file servers, application servers, e-mail, and internal Web sites—while also helping significantly simplify remote management for administrators.

COMPARING TRADITIONAL SOLUTIONS WITH DIRECTACCESS

Traditional VPN solutions generally require mobile users to carry out several steps, including launching the VPN client, providing login credentials, and waiting for authentication. For some enterprise networks that must check the client system's health before allowing a connection, establishing a VPN connection can potentially take several minutes. This process can become even more cumbersome as users move around and as connections to the Internet become intermittent—whenever users lose their Internet connection, they must go through the same process to reestablish the VPN connection. VPN connections can also be problematic in some environments that filter out VPN traffic, and if the VPN implementation forces both Internet and intranet traffic to be routed through the VPN, performance can become a problem.

Utilizing application gateways such as the Citrix Access Gateway™ or Microsoft Office Outlook® Web Access solutions can provide an alternative to a VPN connection, but these solutions are not designed to provide access to all intranet resources. Outlook Web Access, for example, offers access to e-mail, but not to file shares or internally hosted application servers and Web sites.

Traditional VPN solutions can also present significant challenges for IT administrators. Because the remote clients are not always connected to the VPN, pushing software updates and performing other management tasks can be difficult. Ensuring secure communication from the remote clients over the Internet to the enterprise intranet is also challenging.

The DirectAccess feature is designed to overcome these obstacles by maintaining a bidirectional connection between client systems and the intranet as long as the client is connected to the Internet—enabling remote users to access enterprise intranet resources without a VPN connection while also offering enhanced manageability for administrators (see Figure 1). For example, to help reduce unnecessary intranet traffic, DirectAccess separates intranet traffic from Internet traffic by default, routing only traffic bound for the intranet to the DirectAccess server (although IT staff can optionally configure DirectAccess to send all traffic through the DirectAccess server). And unlike traditional VPN solutions, which typically provide all-or-nothing connectivity to the intranet, DirectAccess can provide different levels of access control. Administrators can use Group Policy to control resource accessibility, granting remote users unlimited access to all intranet resources or limiting that access to specific applications, servers, or subnets.

The automatic bidirectional connection provided by DirectAccess also helps simplify remote client management: as long as a client system is online, it is visible on the intranet, and administrators can remotely push software updates and perform other management tasks just as if the client were physically connected to the intranet. This capability helps ensure remote clients can be updated regularly.

UNDERSTANDING THE UNDERLYING TECHNOLOGIES

The DirectAccess feature is built on IP Security (IPsec) and IP version 6 (IPv6) technologies. It uses computer certificates to authenticate remote client accounts, enabling seamless connectivity without requiring end users to provide login credentials.

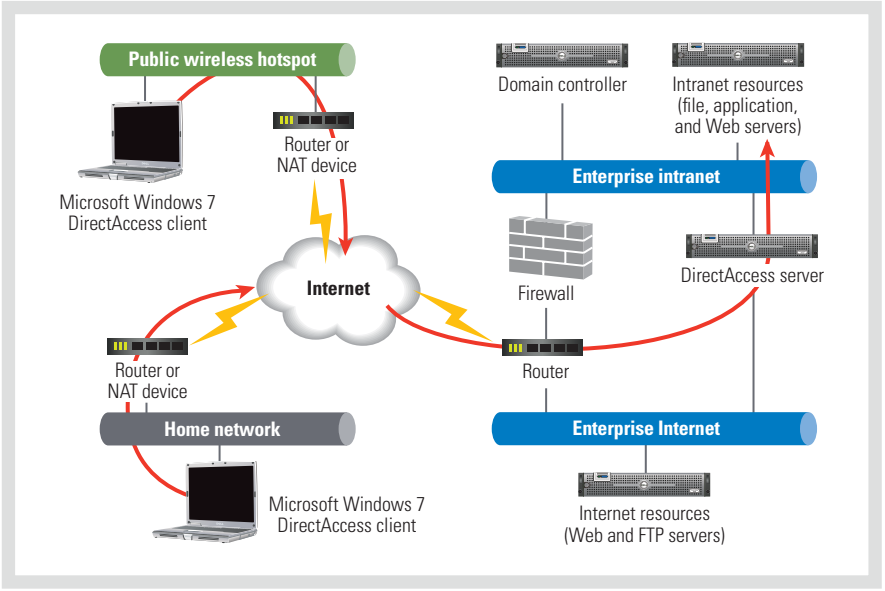

Figure 1. *Microsoft DirectAccess topology*

IPsec authentication and encryption

DirectAccess uses IPsec to support secure communication between remote clients and the enterprise intranet. IPsec is a set of open standards that provides a flexible framework designed to secure network communications by authenticating and encrypting each IP packet of a data stream. DirectAccess authenticates both the clients and users with IPsec, and administrators can manage the clients before users log on. DirectAccess also uses IPsec to encrypt communication across the Internet. DirectAccess clients establish an IPsec tunnel for the IPv6 traffic to a DirectAccess server, which acts as a gateway to the intranet.

DirectAccess clients can connect to a DirectAccess server across the public IPv4 Internet, and can connect even if they are behind a firewall. Using the Encapsulating Security Payload (ESP) protocol, DirectAccess establishes two IPsec tunnels: one that uses a computer certificate and another that uses both a computer certificate and user credentials. The first tunnel provides access to an intranet Domain Name System (DNS) server and domain controller, allowing clients to download Group Policy Objects and request authentication on the user's behalf. The second tunnel authenticates users and provides access to intranet resources and application servers; this tunnel would need to be established, for example, before Microsoft Outlook could download e-mail from a Microsoft Exchange server on the intranet.

IPv6 and transitional technologies

IPv6 provides the foundation of the DirectAccess solution. This implementation enables DirectAccess clients to be assigned as globally routable addresses. For organizations that already have a native IPv6 infrastructure, DirectAccess can provide a seamless connection between DirectAccess clients and a DirectAccess server. In addition, if a remote client connects directly to the IPv6 Internet and has a globally routable IPv6 address, the end-to-end DirectAccess connection can be established using native IPv6.

The protocol used to connect the clients to the intranet depends on the type of Internet connection. IPv4 is still the dominant protocol on the Internet and on enterprise intranets, and DirectAccess can be

used with IPv6 transitional technologies without the need for organizations to upgrade their existing infrastructure.

Figure 2 illustrates the typical process for a DirectAccess client to connect to a DirectAccess server. In most cases, connecting from the IPv4 Internet requires the 6to4 and Teredo tunneling protocols. If the client has a public, routable IPv4 address, then it uses the 6to4 protocol to tunnel IPv6 over the IPv4 Internet. If the client is behind a Network Address Translation (NAT) device such as a home router and therefore has a private, nonroutable IPv4 address, then it uses the Teredo protocol. If the 6to4 or Teredo protocols are blocked by a firewall, then the client can use an IP over HTTP over Secure Sockets Layer (IP-HTTPS) session, which tunnels IPv6 over an IPv4 HTTPS session to get through the firewall. IP-HTTPS is used as a last resort because the additional overhead associated with HTTPS can reduce performance.

DirectAccess clients can only access intranet resources with an IPv6 address; reaching IPv6 resources on an IPv4-based intranet requires Intra-site Automatic Tunnel Addressing Protocol (ISATAP) or NAT–Protocol Translation (NAT-PT). ISATAP is an IPv6 transition mechanism designed to transmit IPv6 packets between dual-stack nodes (running IPv4 and IPv6 at the same time) on top of an IPv4 network, and provides connectivity between IPv4 and IPv6 on IPv4-only intranets. DirectAccess uses ISATAP to provide this connectivity to the intranet resources made available to the DirectAccess clients.

Hardware-based NAT-PT provides an alternative to ISATAP. NAT-PT is typically provided by Layer 2 and Layer 3 infrastructure switches and routers, and provides the required IPv4-to-IPv6 translation required for the DirectAccess clients to access intranet resources. In addition, deploying NAT-PT devices can enable DirectAccess clients to access intranet resources that do not yet support IPv6.

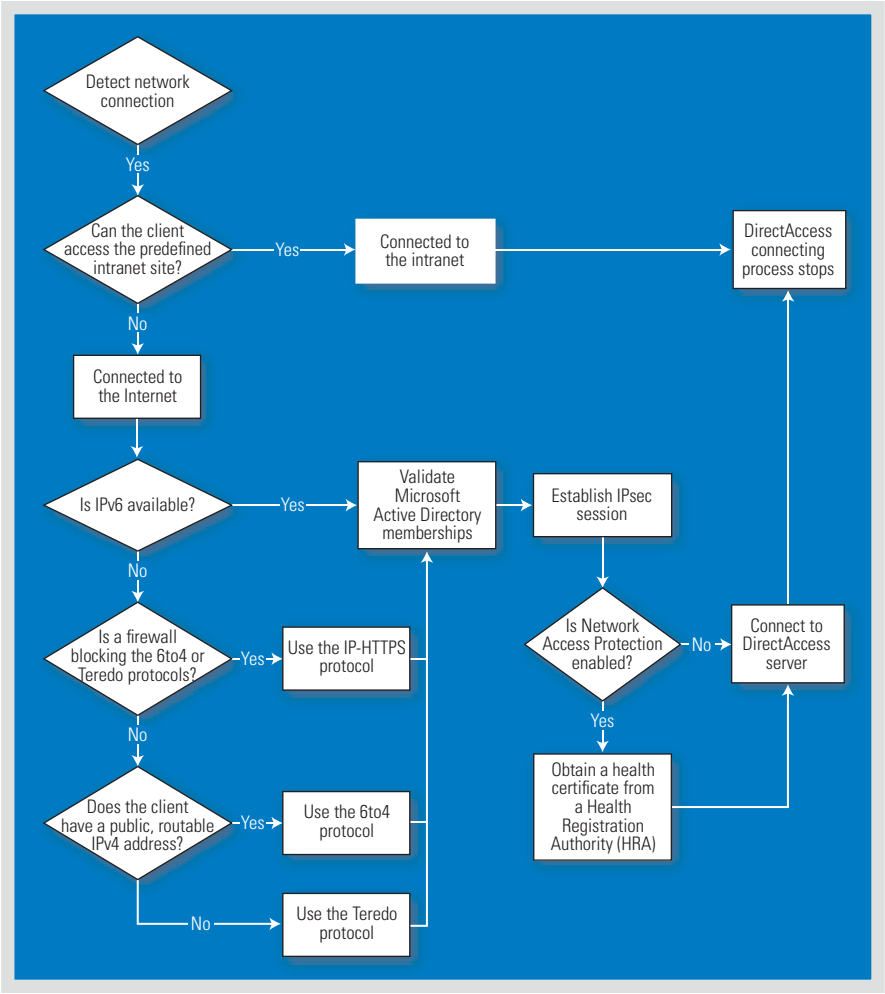

Figure 2. *Typical process for connecting a Microsoft DirectAccess client to a DirectAccess server*

CONFIGURING AND DEPLOYING DIRECTACCESS

Each DirectAccess server must be running Windows Server 2008 R2 and have the DirectAccess feature installed. Because these servers reside at the edge of the intranet, they must also be configured with at least two physical network interfaces: one connected to the Internet and one connected to the intranet. The interface connected to the Internet must have two consecutive, publicly addressable, static IPv4 addresses bound to it, and cannot be behind a NAT device. The DirectAccess server must be joined to a Microsoft Active Directory® domain and should be dedicated to DirectAccess. DirectAccess clients must be running Windows 7 Enterprise or Ultimate or Windows Server 2008 R2, and must be joined to the Active Directory domain.

DirectAccess also requires the following infrastructure components:

- **Active Directory:** Installing the Active Directory Domain Services role on a server running Windows Server 2008 R2 provides directory services, user accounts, and security groups. At least one domain controller is required.
- **Group Policy:** Group Policy provides centralized management of security policies on the DirectAccess clients.
- **Public Key Infrastructure (PKI) Active Directory Certificate Services:** These services are required for the issuance of computer certificates used for authentication. All Secure Sockets

Layer (SSL) certificates must have a certificate revocation list (CRL) distribution point that is reachable from a publicly resolvable fully qualified domain name (FQDN), regardless of whether the DirectAccess client is on the Internet or an intranet.

- **IPsec policies:** Administrators can use Windows Firewall with Advanced Security to manage IPsec policies and create exception rules.
- **Internet Control Message Protocol version 6 (ICMPv6) Echo Request traffic:** Separate inbound and outbound rules are required to allow ICMPv6 Echo Request messages.
- **IPv6 and transition technologies:** These technologies provide access from the IPv4 Internet to IPv6 DirectAccess resources.

Figure 3 shows the basic steps for deploying DirectAccess. As shown in the figure, using the Dell™ Systems Build and Update Utility or the Dell Lifecycle Controller on an 11th-generation Dell PowerEdge™ server can streamline OS deployment and complete several DirectAccess deployment processes in one step, helping reduce total deployment time. In addition, the Lifecycle Controller can provide the latest compatible drivers during Windows Server 2008 R2 deployment.

After deploying the Windows Server 2008 R2 OS, administrators next deploy and configure DirectAccess on the remote clients, DirectAccess server, infrastructure servers, and application servers. Available deployment methods include using the DirectAccess Management Console, the Netsh.exe tool for scripted installation, or Group Policy Objects for manual client configuration. The DirectAccess Management Console helps simplify configuration by providing a set of steps and wizard pages (see Figure 4); the console is located in the Windows Server 2008 R2 Administrative Tools and can be installed through the Add Features function.

To help increase throughput, avoid downtime, and protect against a single node failure, best practices recommend using two Microsoft Hyper-V™ host servers with failover clustering to support a single shared DirectAccess server in a virtual machine. Before running the DirectAccess Setup Wizard, administrators should carry out the following recommended configuration steps on the Hyper-V servers:

- Ensure that the servers have identical hardware with Data Execution Prevention and Intel® Hyper-Threading Technology enabled. Each server needs at least three network adapters to serve the Internet, intranet, and failover clustering.
- Join the servers to the domain and deselect IPv4 and IPv6 on the network adapter for the Internet connection.
- To enhance performance, open the Failover Cluster Manager snap-in, do not set a preferred owner, and set the Failback option in the virtual machine properties to "Prevent Failback."
- To help accelerate client reconnection when a node fails, enable NLBSFlags in the registry by setting the `HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\PolicyAgent\Oakley\NLBSFlags` value to 1.[1]

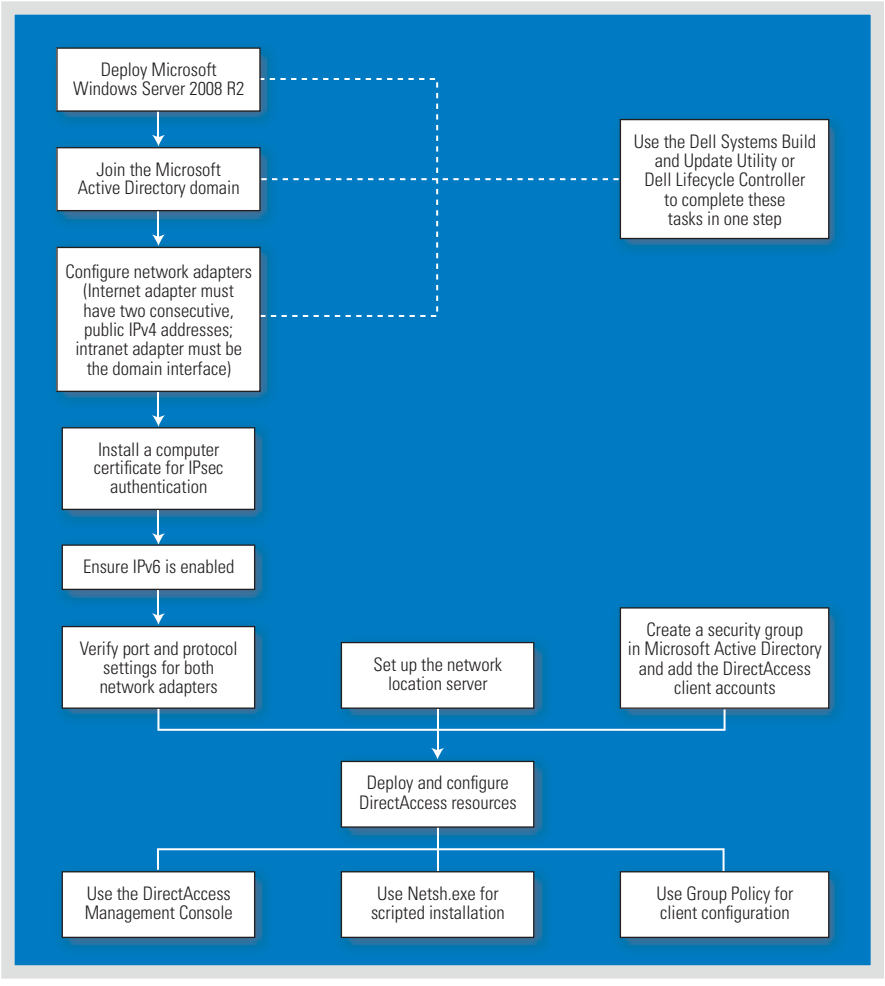

Figure 3. *Typical process for deploying Microsoft DirectAccess*

[1] For more information on setting up DirectAccess, see "Step by Step Guide: Demonstrate DirectAccess in a Test Lab," by Microsoft Corporation, May 2009, available at www.microsoft.com/downloads/details.aspx?displaylang=en&familyid=8d47ed5f-d217-4d84-b698-f39360d82fac.

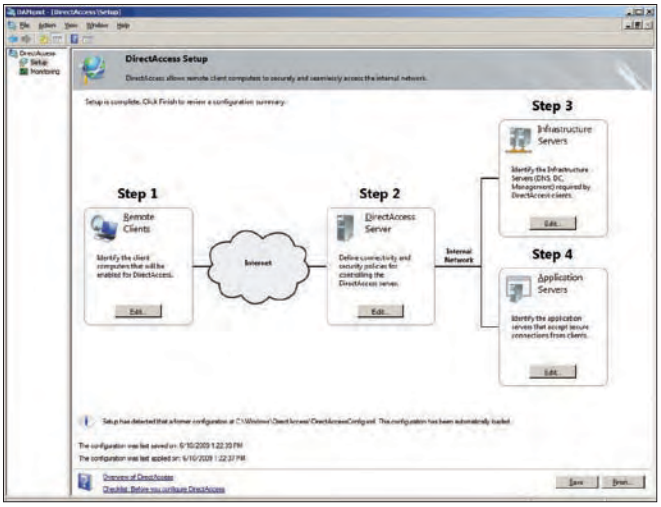

Figure 4. *Microsoft DirectAccess setup in the DirectAccess Management Console*

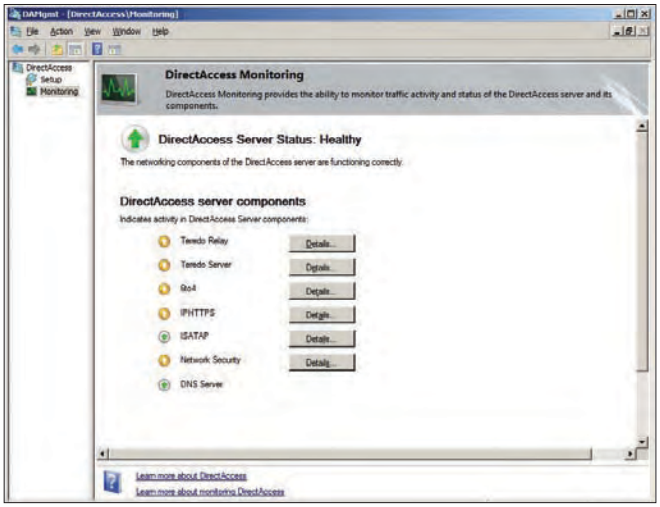

Figure 5. *Microsoft DirectAccess Monitoring snap-in*

MONITORING DIRECTACCESS

Administrators should monitor DirectAccess to help them quickly identify and troubleshoot problems. They can perform local monitoring using the DirectAccess Monitoring snap-in for the Microsoft Management Console, which is incorporated into Windows Server 2008 R2 and installed with the DirectAccess server feature. An enterprise deployment of multiple DirectAccess servers can be created by installing a management pack for Microsoft System Center Operations Manager 2007 with Service Pack 1 (SP1).

DirectAccess Monitoring snap-in

The DirectAccess Monitoring snap-in enables administrators to locally monitor server status, traffic patterns, and events. The overall DirectAccess server status is based on the state of the Teredo Relay, Teredo Server, 6to4, IP-HTTPS, ISATAP, Network Security, and DNS Server components (see Figure 5).

Each component can be in a healthy, warning, or error state. If a component is in a warning or error state, a detailed error message is displayed along with suggestions to correct the problem. Clicking the Details button next to each component launches performance-monitoring and load-performance counters associated with that component, helping administrators to identify potential problems.

System Center Operations Manager 2007

A management pack for System Center Operations Manager 2007 with SP1 supports centralized, one-to-many monitoring of multiple DirectAccess servers in large enterprise deployments. In addition to proactive monitoring, System Center Operations Manager adds enhanced capability for alarms and reporting and provides a convenient view showing the DirectAccess servers and their component states.

In addition, with the latest release of the Dell OpenManage™ suite, the Dell Management Console Powered by Altiris™ from Symantec™ can help administrators manage the DirectAccess infrastructure. The Dell Management Console enables administrators to monitor both Dell and non-Dell devices; monitor processors, memory, and alerts; push BIOS, firmware, and driver updates to Dell PowerEdge servers; and push configuration changes to multiple devices simultaneously.

PROVIDING SEAMLESS, SECURE REMOTE CONNECTIVITY

Although traditional solutions such as VPNs and application gateways can provide the remote connectivity required by an increasingly mobile workforce, these approaches can also present obstacles for end users and a myriad of difficulties for IT administrators. The DirectAccess feature incorporated into the Microsoft Windows 7 and Windows Server 2008 R2 operating systems is designed to overcome these challenges—not only helping provide seamless, secure connections for remote users, but also helping significantly simplify ongoing management for enterprise administrators.

Steven Grigsby is a software engineer in the Dell Server Operating Systems Group. He has a B.S. in Computer Science from the University of Oklahoma.

Gong Wang is a software engineer in the Dell Server Operating Systems Group. He has an M.S. in Human-Computer Interaction from the Georgia Institute of Technology.

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ENHANCING WAN PERFORMANCE WITH MICROSOFT WINDOWS SERVER 2008 R2 BRANCHCACHE

By David Waggoner
Joseph Rojas

The new BranchCache™ feature integrated into the Microsoft® Windows® 7 and Windows Server® 2008 R2 operating systems can help reduce wide area network (WAN) traffic, boost network application responsiveness, enhance security, and increase productivity for end users accessing centrally stored content from branch office locations.

Imagine a large health care network with remote offices around the world, supporting hundreds of doctors or researchers who need access to information generated at the central office. This information is turned into daily reports that are automatically placed on a file share or Microsoft Office SharePoint® site, and dozens of these files are then accessed throughout the day by a variety of people in each remote office.

Traditionally, IT administrators could choose to support this remote access in a number of ways: purchasing and installing direct high-bandwidth network connections or hardware caching devices, synchronizing files down to a local server before the workday begins, or simply having users wait for files to open over the wide area network (WAN). These approaches may solve the problem, but can also be expensive, difficult to manage, or inconvenient for end users.

With the introduction of the Microsoft Windows 7 and Windows Server 2008 R2 operating systems, administrators can take advantage of a new tool designed to solve this problem simply and transparently for both end users and administrators: BranchCache. BranchCache is designed to automatically retrieve content from centralized servers and cache that data either on a local server or on local client systems—helping to reduce WAN traffic, boost network application responsiveness, and increase efficiency for end users accessing this content. This feature works with the HTTP and HTTP over Secure Sockets Layer (HTTPS) protocols commonly used on enterprise intranets and with the Server Message Block (SMB) protocol commonly used on file servers. BranchCache is designed for security, supporting IP version 4 (IPv4), IPv6, and encryption methods such as Secure Sockets Layer (SSL) and IP Security (IPsec); it also respects the permissions set on files at the main office, and access can be altered on the fly without requiring a lengthy replication process or manual management of a large number of file servers. BranchCache avoids the problems of stale files or conflicting versions by requesting a hash list on each access, which is designed to verify that the file stored in the cache exactly matches the one on the central server. (To help prevent this request from causing unnecessary delays, BranchCache only functions with files larger than 64 KB.)

BranchCache is an extension of the offline-files feature in previous Windows versions; it requires that the content servers be running Windows Server 2008 R2 and that participating client systems be running Windows 7 Enterprise or Ultimate. Client configuration can be scripted or performed using Group Policy, and this configuration is designed to be transparent to end users. After installing the File Services role and selecting the BranchCache component, administrators can set BranchCache for SMB to function on a server or share level. Using BranchCache with HTTPS

does not require the File Services role; in this case, administrators can use the Server Manager console to enable the feature. Administrators should keep in mind that only applications that use the standard HTTP or SMB interfaces can automatically take advantage of BranchCache. Applications that programmatically implement their own HTTP or SMB stacks cannot benefit, because BranchCache optimizations are directly embedded into Windows 7 and Windows Server 2008 R2.

HOSTED CACHE MODE

BranchCache Hosted Cache mode uses a server running Windows Server 2008 R2 Enterprise or Datacenter to cache files. This mode has the advantage of a dedicated host that, ideally, can be available whenever it is needed. Administrators can configure the cache size on the server so that a specific amount of space is dedicated to BranchCache, and unlike a normal file server, old or stale documents are not retained. In contrast to Distributed Cache mode, Hosted Cache mode also offloads the network traffic from the client systems and can offer greater reductions in bandwidth usage and file access latency—especially in branches where a majority of users have laptops and come and go frequently, or primarily use wireless connections.

Figure 1 illustrates how Hosted Cache mode works. In this example, the Dell™ Latitude™ client user attempts to open a file on the main office server. The client-side caching (CSC) service—an OS component for offline files—intercepts the request and, assuming the latency is above the set limit, requests that the main office server provide a current hash list. If the server's hash list is missing or outdated, it generates a new one, and then sends the up-to-date list to the client. The client sends this hash list to the branch office server and requests the local copy of the file. If the file is present and matches the current file at the main office, the client opens that copy. If the file is not present or is outdated, the client downloads the file directly from the main office server, then caches it at the branch office server as a local copy for other clients to access.

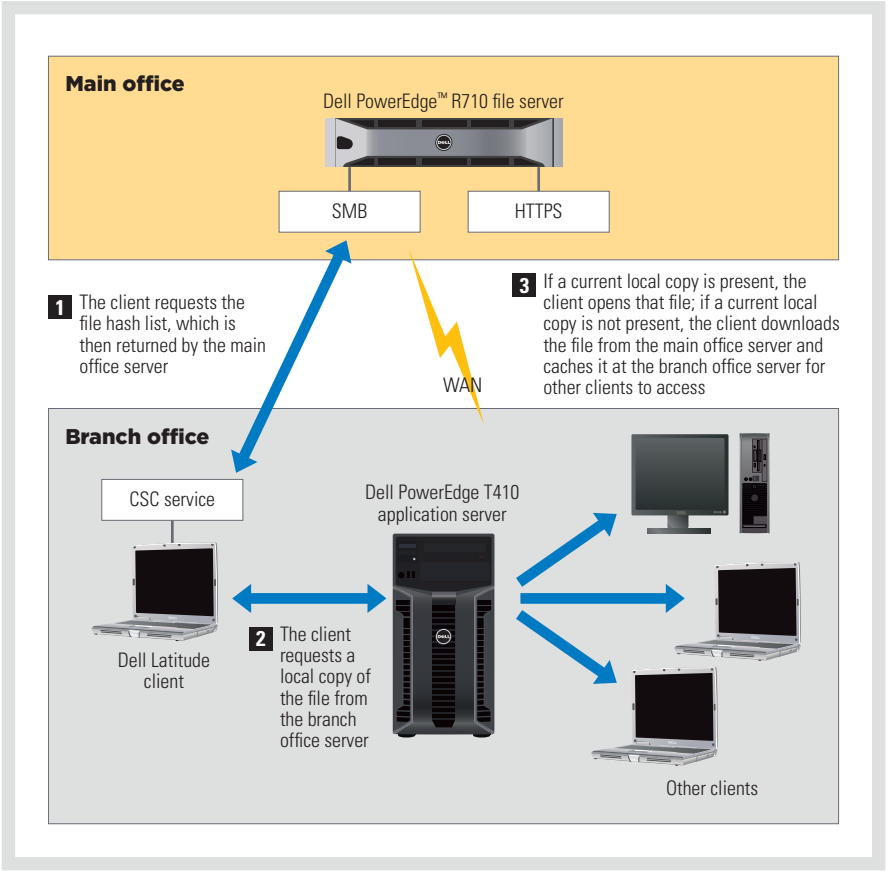

Figure 1. *Example file retrieval using Microsoft BranchCache Hosted Cache mode*

This process is generally transparent to the end user. Initial users of a file from the main office server may experience a very short delay while the hash list request is fulfilled, but subsequent local users of that file gain the advantage of not having to wait for the original file to be copied across the WAN. In the example of the health care network, administrators could also help further minimize client access delays by configuring BranchCache to pre-generate the hashes for all reports immediately after the reports are finished.

DISTRIBUTED CACHE MODE

Branch offices may often be too small to warrant a dedicated server, or the offices themselves may be mobile. In this case, administrators can instead use Distributed Cache mode, which caches files using local client systems rather than a server. This mode is typically recommended only for offices with fewer than 50 users, and requires that the server at the main office be running Windows Server 2008 R2 and that the clients at the branch office be running Windows 7. If a branch office has multiple subnets, then a client on each subnet downloads the necessary file and shares it with the other clients on each respective subnet. Distributed Cache mode requires no additional infrastructure or services at the branch office, and offers a cost-effective and simplified way for administrators to reduce WAN traffic and minimize user wait time for commonly used files while still maintaining file security.

Figure 2 illustrates how Distributed Cache mode works. First, a Dell Latitude client user attempts to open a file on the main office server. The client communicates with the server using headers integrated into the BranchCache-supported

protocol. The server responds and transmits a set of identifiers that describes the requested file. The client then uses BranchCache Web Services Dynamic Discovery (WS-Discovery)—a multicast protocol sent over User Datagram Protocol (UDP)—to search locally for another client that may have already downloaded and cached the file. Because in this example the client is the first in the branch office to download this file, no responses are received. The client then issues another request to the file server for the full file, which is automatically added to the client's local cache.

Later, a second Dell Latitude client user attempts to open the same file. After issuing the request for the file, the client receives the identifying descriptors from the main office server and uses the BranchCache WS-Discovery protocol to search local clients for that file. The first client receives the request, locates the requested file in its local cache, and responds, allowing the file copy to begin through the BranchCache HTTP retrieval protocol. While the transfer occurs, the file is protected using the BranchCache encryption scheme. The second client verifies the file against the identifiers downloaded from the main office server, and the transaction is completed without the need to download the file from the main office.

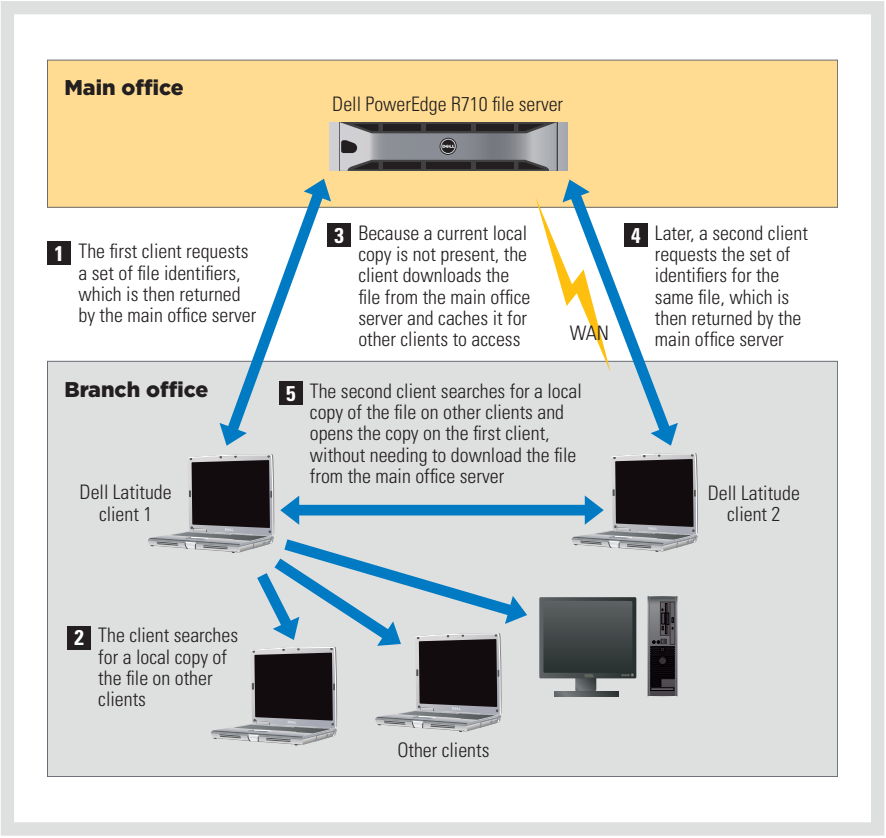

Figure 2. *Example file retrieval using Microsoft BranchCache Distributed Cache mode*

OPTIMIZED WAN PERFORMANCE

The BranchCache feature can provide major advantages for certain types of operations over a WAN, particularly for large numbers of remote client systems that frequently access the same information; it would generally be less helpful in situations where all files on the main office server are generated on the fly, change constantly, or are only accessed by a single user. The appropriate mode depends on the specific environment and resources. Although Hosted Cache mode helps reduce the impact of file sharing on clients and may make more space available for caching, it does require a server in the branch office along with the associated maintenance and management burdens. In some organizations, the best option may be a combination of the two, with large branches using Hosted Cache mode and smaller branches using Distributed Cache mode.

BranchCache can provide organizations with a cost-effective, simplified way to increase WAN performance without requiring an investment in dedicated hardware. BranchCache is designed to optimize WAN connectivity from end to end, maintaining protocol integrity over secure channels such as SSL and IPsec—which is typically much more secure and efficient than simply copying a set of files and letting them sit on a local file server, while also helping ensure that the files themselves are current. The results, which can include savings on management and dedicated hardware as well as an increase in end-user satisfaction, can make BranchCache well worth the implementation effort in organizations reliant on WAN connections.

David Waggoner is a software engineer in the Dell Server Operating Systems Group.

Joseph Rojas is a software engineer in the Dell Server Operating Systems Group.

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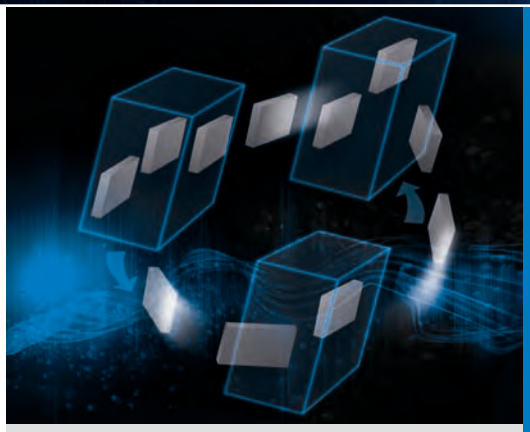
VIRTUAL DESKTOP INFRASTRUCTURE IN MICROSOFT WINDOWS SERVER 2008 R2



Virtual desktop infrastructure solutions based on the Microsoft® Windows Server® 2008 R2 Hyper-V™ platform, Microsoft System Center Virtual Machine Manager 2008 R2, and Dell™ servers and storage offer an efficient, high-performance foundation for enterprise desktop virtualization—helping to increase security, streamline client deployment and management, and reduce costs.

By David Waggoner
Ravikanth Chaganti
Gangadhar D. Bhat

Virtual desktop infrastructure (VDI) is built on a concept that has been around since the early days of computing. The term itself reflects some of the changes that have occurred in this area since the days of mainframes with remote terminals, and encompasses solutions that replace distributed desktop systems with virtual machines (VMs) that reside on centralized servers (usually with networked storage).

VDI solutions based on Microsoft Windows Server 2008 R2 Hyper-V, Microsoft System Center Virtual Machine Manager (SCVMM) 2008 R2, and Dell servers and storage provide a robust, flexible way to implement enterprise desktop virtualization (see the "Testing Microsoft VDI on Dell PowerEdge server clusters" sidebar in this article). Understanding the architecture and requirements of VDI, as well as its advantages and disadvantages, can help administrators create efficient, high-performance VDI deployments in their own environments.

VDI AND REMOTE DESKTOP SERVICES

VDI generally describes end users remotely accessing a full desktop OS environment. The end users typically connect through Remote Desktop Protocol (RDP) to an individual VM running a Microsoft Windows® client OS; they can connect from a PC running its own OS or from a thin client that includes only the software to support the RDP connection.

The ability to remotely access a virtual desktop has been available for many years through Terminal Services, now called Remote Desktop Services (RDS) in Windows Server 2008 R2. In a Terminal Services or RDS environment, multiple users access a single OS that, although usually customized on a per-user basis, lacks dedicated resources for specific users. In a VDI environment, in contrast, each user accesses a dedicated VM with an OS instance that is not shared with other users. VDI enables applications to be run as if they are on an individual PC, helping avoid the issues that can arise when running applications in an RDS environment (which can be common, because many applications are not designed for use with RDS). In a VDI environment, physical processor, memory, and disk capacity can be allocated to specific users, helping limit the effect of one user's actions on other users.

The authors would like to thank Terry Storey of the Dell Global Infrastructure Consulting Services team for key contributions to this article.

TESTING MICROSOFT VDI ON DELL POWEREDGE SERVER CLUSTERS

During Microsoft development of Windows Server 2008 R2 Hyper-V and key management tools, Dell internal testing and early site deployments resulted in Dell filing several hundred issues and dozens of design change requests to help improve the software involved in Microsoft virtual desktop infrastructure (VDI) solutions—Windows Server 2008 R2 Hyper-V, System Center Virtual Machine Manager (SCVMM) 2008 R2, and Remote Desktop Services (RDS). Dell also ensured that updated, dedicated hardware was available to the Microsoft virtualization teams.

This hardware included a Dell PowerEdge™ M1000e modular blade enclosure with a mix of Intel® Xeon® processor–based PowerEdge M600 blade servers and AMD Opteron™ processor–based PowerEdge M605 blade servers. The servers incorporated a variety of mezzanine cards to support different networking and storage protocols, including Fibre Channel and Internet SCSI (iSCSI). The servers were also configured with a mix of processor types to help develop and test features such as compatibility mode, which enables virtual machine (VM) live migrations across broad families of processors. The different processors also allowed testing of the quick migration feature across the cluster.

This particular combination of blade enclosure and blade servers, deployed in a single cluster, was used during development to test the limits of Hyper-V and SCVMM performance in a VDI configuration. During this testing, the cluster was consistently able to support over 1,000 VDI VMs in a usable way (see Figure A). The VMs were successfully live migrated or quick migrated while certain operations were run inside the VMs to gauge their performance. This testing was instrumental in helping to determine the final maximum supported limit of 64 VMs per cluster host, and to help ensure that unnecessary limitations or performance hindrances were caught.

Working with a large number of VMs can be difficult and time-consuming, depending on the deployment mechanism used. Managing such a large number of VMs exposed several issues in the Hyper-V and SCVMM consoles, and led to changes enabling administrators to start, save, shut down, and edit multiple highly available VMs simultaneously.

The deployment of 1,000 VMs in a 16-node cluster was certainly challenging: the test team achieved this deployment by creating a single master Windows 7 virtual hard disk (.vhd) file with a fully configured unattend.xml file that automatically answered all prompts and performed the language selection, licensing, and naming steps. A Windows PowerShell™ script was used to export and copy the 9 GB .vhd file 1,000 times across the 16 cluster nodes.

The Windows PowerShell script processed these VMs in a batch using the resources of the cluster members, and was able to create approximately 320 VMs every 20 minutes. This process enabled the team to create all 1,000 VMs in just over an hour—although in reality, including all of the configuration and system setup time, it took approximately 24 hours to get from one functioning VM to 1,000 VMs. After the mass creation, approximately 4 percent of the VMs had some issue, with most of those (such as failed Microsoft Active Directory® joins) being relatively easy to correct.

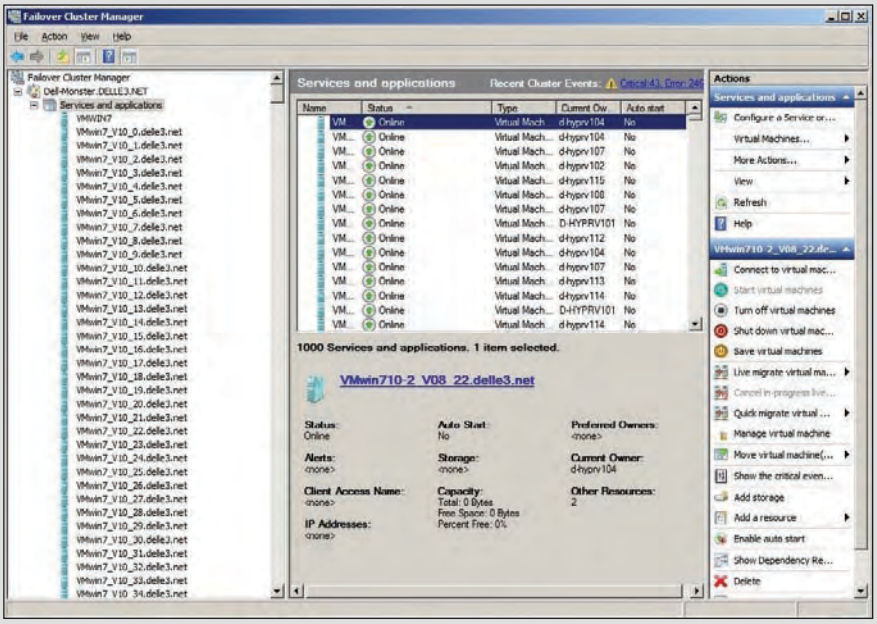


Figure A. *Dell PowerEdge blade server cluster supporting 1,000 Microsoft VDI VMs*

VDI can offer several advantages, including the following:

- **Reduced costs:** With few (or no) moving parts, thin clients can often last longer than traditional PCs, and are typically less expensive to operate and maintain. Legacy PCs not capable of running a modern OS can be repurposed for maximum utility, if upgrade cost avoidance is a more immediate concern than the potential power savings.
- **Rapid client deployment and centralized management:** Because VDI avoids the need for custom hardware and drivers and requires fewer images than traditional deployments, it can help accelerate and simplify

client provisioning and maintenance. Administrators can quickly clone VMs and make them available for use, without requiring refresh time on the client hardware.

- **Enhanced security:** Centralizing clients helps simplify physical security, because no data is kept on the end user's system—the data is inside the VM, which could be kept in a secure facility far away from the user's location. It is also generally easier to secure network access to Hyper-V host servers than to do so for many individual client systems.
- **Simplified backup and recovery:** Having the VMs on server-class hardware inside a data center helps simplify backup and recovery processes for user data and configurations, enabling administrators to take advantage of powerful tape drives, deduplication software, and (in some cases) snapshots. If a VM becomes corrupt, administrators can quickly perform a recovery or simply create a new VM. If users' hardware fails, the VMs are waiting in the same state when they reattach. And because users can connect even on dissimilar hardware or from a different location, if a specific office is inaccessible, they can go virtually anywhere (assuming security allows) and resume work.

VDI can also come with several disadvantages, however. It requires constant connectivity to the network, so network outages or disruptions can limit or prevent users from getting work done. Ensuring redundant, reliable connections with appropriate bandwidth between Hyper-V hosts and end users is therefore a key part of VDI.

In addition, remote protocols may not be well suited for some tasks: high-end graphic design or video editing, for example, can be difficult over RDP because of delays and limited hardware audio and video acceleration. Video content with a high frame rate also generally does not work as well as on a traditional PC with its own OS. Microsoft has introduced significant enhancements in Windows 7 and Windows Server 2008 R2 to help increase multimedia performance in many cases, and content played back using Microsoft Windows Media® Player can be redirected to the user's local client in native format and played back there (assuming the client has the appropriate hardware).[1]

VDI also requires a serious commitment to virtualization, including the appropriate administrative expertise and server, storage, and networking hardware to help ensure uptime and responsiveness. This commitment can increase expenses in the short term, but the more server workloads organizations virtualize, the higher the likelihood that they can leverage the appropriate skill set and hardware.

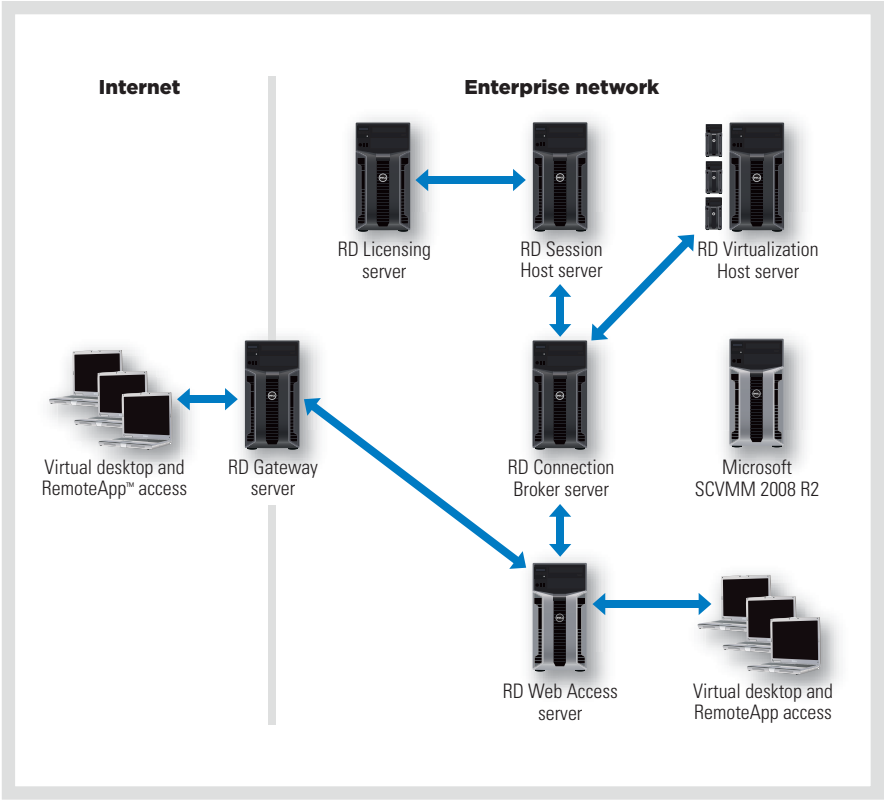


Figure 1. *Typical VDI deployment based on Microsoft Windows Server 2008 R2 Hyper-V*

VDI ARCHITECTURE AND SERVER ROLES

A typical VDI deployment based on Windows Server 2008 R2 Hyper-V has each RDS role installed on a separate physical server (see Figure 1). Typically, when a client system requests access to a virtual desktop, the Remote Desktop (RD) Web Access server first sends the request to the RD Connection Broker server. This server then sends a request to the RD Virtualization Host server to start a VM in the virtual desktop pool. After the VM has started, the RD Connection Broker sends the VM name to the RD Session Host server, which redirects the virtual desktop session to the client. If a virtual desktop request originates from outside the enterprise network or from the Internet, the request is first handled by the RD Gateway server, and then forwarded to the RD Web Access server.

[1] For more information on these enhancements, visit technet.microsoft.com/en-us/library/dd560636(WS.10).aspx.

Server role	Description
RD Web Access	Enables access to Windows-based programs and virtual desktops hosted on an RD Session Host server through either Terminal Services RemoteApp and Remote Desktop Connection or a Web browser
RD Connection Broker	Enables access to load balancing in an RD Session Host server farm
RD Virtualization Host	Enables access to Hyper-V VMs as virtual desktops
RD Session Host	Hosts Windows-based programs and virtual desktops
RD Gateway	Enables access to RDS from Internet-connected devices outside the enterprise network
RD Licensing	Manages client access licenses (CALs) for each device or user accessing an RD Session Host server

Figure 2. *Remote Desktop Services server roles in Microsoft Windows Server 2008 R2*

Administrators should keep in mind that Figure 1 depicts the default behavior of the RD Connection Broker, with no IP redirection or routing token redirection. In this configuration, all client requests would be redirected by the RD Connection Broker to the RD Session Host server.

As shown in Figure 1, VDI implementations require deploying multiple server roles; Figure 2 provides a brief description of each of these roles. The servers hosting these roles, as well as the virtual desktops hosted as Hyper-V VMs, must be in the same Microsoft Active Directory domain.[2]

Using tools like SCVMM can help substantially reduce the amount of time required to provision new virtual desktops. Administrators can also take advantage of new tools introduced in Windows Server 2008 R2 such as offline domain join (djoin.exe) to create preconfigured VM templates in SCVMM and dynamically join them to an Active Directory domain. Administrators should keep in mind that the offline domain join feature is supported only in Windows 7 and Windows Server 2008 R2.

When implementing VDI, administrators should also be sure to plan for increased user loads, changing IT environments, and infrastructure availability. Implementing a load-balancing server farm model within the RDS environment can help ensure that the VDI infrastructure is both scalable and highly available.

LOAD BALANCING AND HIGH AVAILABILITY

Because Microsoft VDI uses Windows Server 2008 R2 RDS as its foundation, building high availability into the RDS environment can be critical. As the number of users accessing virtual desktops increases, the RD Session Host server can potentially become a bottleneck. To help avoid this problem, administrators can configure the RD Connection Broker server to load balance sessions between RD Session Host servers.

Implementing load balancing enables users to reconnect to an existing session in a load-balanced server farm. Administrators can deploy RD Connection Broker load balancing using the traditional Domain Name System (DNS) round-robin method, the native Windows Server 2008 R2 Network Load Balancing (NLB) feature, or a hardware load balancer. Using NLB or a hardware load balancer can help avoid limitations of the DNS round-robin method such as the caching of DNS requests on the clients, which can cause connection problems. In NLB implementations, the RD Connection Broker acts as a front-end coordinator for incoming requests and transfers the requests to the RD Session Host farm. When implementing RD Connection Broker load balancing, all servers in the farm must be running either Windows Server 2008 or Windows Server 2008 R2.

The RD Virtualization Host server integrates with Hyper-V to provide VMs as virtual desktops to end users. Administrators can help ensure high availability for these VMs by configuring the Hyper-V host servers in a failover cluster and enabling the live migration feature, which allows VMs to be migrated between Hyper-V hosts without perceived downtime by end users. Migrations can be performed for maintenance purposes, to help increase performance, or for other administrative reasons.

BEST PRACTICES FOR DEPLOYMENT AND MANAGEMENT

The number of VMs that a Hyper-V host server can support is typically directly proportional to the amount of physical memory on the host. For example, in a host with 16 GB of physical memory running VMs configured to use 1 GB of memory each, the server could only support up to 15 VMs. Administrators should be sure to evaluate their deployments based on the total number of virtual desktops they plan to host and the physical memory required to host them.

On the RD Virtualization Host server, adequate storage space for the virtual hard disk (.vhd) files is essential. Using external storage such as a Dell EqualLogic™ PS6000X Internet SCSI (iSCSI) array to host the .vhd files for each VM may help increase I/O performance and redundancy.

Each RDS component has its own management console for configuring and

[2] For more information on VDI server roles, visit technet.microsoft.com/en-us/library/dd560658(WS.10).aspx.

monitoring its functionality. SCVMM supports management of VMs that are a part of the VDI deployment, providing a centralized console for managing RD Virtualization Host servers across the enterprise. Key features of SCVMM 2008 R2 include VM templates, the ability to perform scheduled jobs, integrated live migration and quick migration capabilities, and more, helping to simplify the deployment and management of virtual desktops.[3]

FLEXIBLE, EFFICIENT INFRASTRUCTURE

VDI is designed to enable end users to access their individual desktops and data safely from virtually any network, while helping IT administrators to increase security, accelerate deployment of new capabilities without requiring the deployment and configuration of new hardware, reduce application testing requirements and compatibility issues, and simplify disaster recovery and compliance. For the enterprise, implementing VDI can help reduce hardware costs, client servicing requirements, and overall power consumption. Investing in a VDI solution based on Microsoft Windows Server 2008 R2 Hyper-V, Microsoft SCVMM 2008 R2, and highly efficient Dell servers and storage can help maximize flexibility and efficiency and help lower the costs of providing desktop services to end users.

David Waggoner is a software engineer in the Dell Server Operating Systems Group.

Ravikanth Chaganti is a lead engineer on the Dell Enterprise OS Engineering team.

Gangadhar D. Bhat is a senior Microsoft Windows debug engineer on the Dell Enterprise OS Engineering team.

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Microsoft Windows Server 2008 R2:
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www.microsoft.com/windowsserver2008

Microsoft RDS team blog:
blogs.msdn.com/rds

[3] For more information on SCVMM 2008 R2, visit www.microsoft.com/systemcenter/virtualmachinemanager.

EFFICIENT ENTERPRISE: MAKING A SUCCESSFUL TRANSITION TO A GREEN IT INFRASTRUCTURE

By Albert Esser, Ph.D.

Adopting a green IT infrastructure is the key to sustainable growth, and in today's economic climate can often be the difference between simply surviving and flourishing. CIOs can accelerate this transition by cost-justifying strategic IT investments that advance enterprise efficiency while helping to simplify management and reduce operational costs—thereby contributing to a healthy bottom line and a healthy environment.

Between rapidly growing IT infrastructures and high power and cooling costs, today's technology executives have more than enough reasons to explore green, sustainable IT strategies. An ever-increasing demand for IT innovation that advances strategic organizational goals only compounds these challenges. This is why CIOs are striving to drive costs out of IT infrastructures to help free capital resources for strategic investments.

Adopting a green IT strategy can help enterprises to minimize power consumption, maximize resource utilization, reduce management complexity, and decrease operational costs. At the same time, green IT has the potential to dramatically improve overall enterprise efficiency—advancing productivity while facilitating fast, flexible response to evolving business conditions.

Although demonstrating environmental responsibility can be an important motivator for going green, these efforts can have concrete benefits for the bottom line as well. Quantifying data center efficiency helps to establish return on investment (ROI) for IT projects and data center infrastructure costs. In addition, measuring efficiency in terms of IT work performed—not just energy consumed—can be critical to building a true picture of the value of green IT.

To help organizations address the challenges of efficiency and sustainability, Dell has developed a "compute more, consume less" approach to analyze total data center efficiency with the potential to provide important guidance on IT policy changes, offering a solid foundation for cost-efficient IT implementations. This approach is also designed to quantify financial returns in language that helps business executives understand how strategic IT investments can pay off on the bottom line. The goals of the Dell methodology: refresh aging IT infrastructures with efficient, high-performance systems such as 11th-generation Dell™ PowerEdge™ servers with the Intel® Xeon® processor 5500 series; virtualize systems to help reduce data center power and space requirements, streamline administration, and lower costs; and reduce CO_2 emissions.

FOCUSING ON DATA CENTER EFFICIENCY

Data centers account for a significant proportion of the energy used within most organizations—and energy use is synonymous with greenhouse gas (GHG) emissions. Therefore, a green efficiency approach to IT makes good business sense as well as environmental sense—helping enterprises save on operational expenditures through decreased energy use while also contributing significantly toward reducing GHG emissions.

However, many data centers have a lot of room for improvement. Dell estimates that by transitioning to a green IT strategy, a typical traditional data center can potentially become more than 10 times less carbon intensive than it is now (see the example scenarios in the "Step 2: Examine policies affecting green efficiency" section in this article). Reducing GHG emissions from the data center can also translate to enormous cost savings.

A variety of tactics can help CIOs enhance data center efficiency and reduce GHG emissions, including the following:

- Refresh legacy servers and standardize with energy-efficient, latest-generation models.
- Specify efficiency levels—for example, power supply units (PSUs) with efficiency ratings of 90 percent or higher—and make them part of every request for quotation (RFQ).
- Set ROI goals for IT that are just as rigorous as those set for other business units, such as factories and operations.
- Set quantifiable cost-efficiency goals. Through small up-front investments, green IT helps drive cost-effectiveness in the data center by providing the foundation for heightened efficiency levels.
- Buy renewable energy.
- Use recyclable and recycled materials.
- Give every team within the IT department a goal that contributes toward making the IT infrastructure green. Going green requires support throughout the organization—it cannot be a top-down or solo effort.

TAKING KEY STEPS ALONG THE PATH TO GREEN IT

Getting started along the path to a green data center does not have to be a complex undertaking. Three critical steps—evaluating energy use, examining policies affecting green efficiency, and taking action—can empower CIOs to reduce both infrastructure costs and GHG emissions.

Step 1: Evaluate energy use

The first step in managing energy use is to be able to measure and quantify it. To establish a baseline on which to improve, IT executives should start by conducting an energy audit. By categorizing energy use by purpose (such as IT work or ancillary functions like cooling), they can understand where energy is actually being used within the data center and examine the tasks that consume a disproportionate share of overall costs. System-level instrumentation in Dell PowerEdge servers with the Intel Xeon processor 5500 series can help organizations understand how much power these systems consume under normal operating conditions.

Step 2: Examine policies affecting green efficiency

Objectively assessing the value of IT expenditures, especially for green IT investments, can be done by using a holistic metric that can describe the efficiency of the entire data center. Data Center Infrastructure Efficiency (DCiE)—the conventional measure IT leaders have used to evaluate the effectiveness of power consumption in the physical infrastructure—can be expanded by looking at additional aspects contributing to data center efficiency. DCiE does not factor in overall IT productivity or take into account whether the IT equipment is idle or heavily used. For these reasons, Dell suggests augmenting DCiE to measure the total value delivered by the data center.

Measuring four basic types of efficiency can help IT leaders assess the ability of their data centers to convert electricity into IT work: DCiE, IT Age Mix Efficiency (ITAME), IT Utilization Efficiency (ITUE), and IT Efficiency (ITE). Multiplying these values offers a way to assess overall data center efficiency—which also allows organizations to compare productivity across data centers with different configurations and different workloads. Dell calls this comprehensive assessment Total Data Center Efficiency (TDCE):

TDCE = DCiE × ITAME × ITUE × ITE

TDCE describes the efficiency of converting energy into IT work. Because it accounts for the relationship between work production and resources used, it does not require a definition of the absolute IT work done in units, assuming the same useful IT work is desired. It also provides an approximation that can be used to assess the level of CO_2 efficiency or "greenness" of a data center. The goal: allow IT decision makers to quickly identify specific areas to target for improvement. Figure 1 illustrates several scenarios using a variety of example values for each

	DCiE (physical infrastructure)	ITAME (capital expenditure write-off schedule)	ITUE (virtualization)	ITE (OEM and vendor qualification)	TDCE (total efficiency)	Relative CO_2 efficiency (operational energy cost)
Typical	50.0%	56.0%	15.0%	100.0%	4.2%	100.0%
Improved	60.0%	63.8%	29.0%	100.0%	11.1%	37.8%
Better	70.0%	73.4%	52.0%	100.0%	26.7%	15.7%
Very good	75.0%	85.4%	71.0%	100.0%	45.5%	9.2%
Excellent	80.0%	100.0%	79.0%	100.0%	63.2%	6.6%

Figure 1. *Example values showing how increased data center efficiency can help reduce CO_2 emissions*

metric, demonstrating how they affect TDCE and the resulting CO_2 efficiency relative to the "typical" scenario.

In these calculations, DCiE measures the power used to run IT equipment as a percentage of power used to run the entire data center. This metric shows how much of the power going to the data center is being used to run equipment that actually handles the IT workloads, as opposed to power used for cooling and other support functions.

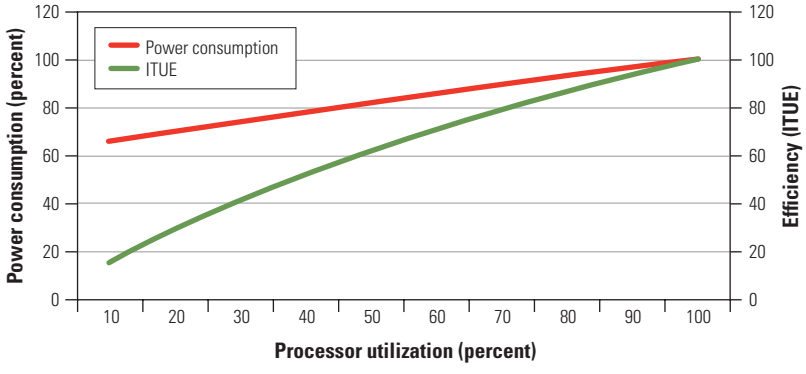
ITAME approximates the effect of Moore's Law in the data center, which conservatively describes the phenomenon where computing ability doubles every two years. The ITAME metric is designed to characterize the effect that server refresh rates have on computing capacity, which in turn contributes to data center efficiency. Applying the converse of Moore's Law would characterize two-year-old equipment as having only 50 percent of the computing capability of new equipment—which, mathematically, can be described as an exponential decay with a half-life of two years.

ITAME is calculated by using this decay to determine the efficiency of legacy servers relative to latest-generation servers; a data center with all-new hardware would have an ITAME of 100 percent. If IT equipment is purchased annually and the entire server infrastructure is refreshed every five years (that is, the oldest 20 percent of servers in the data center are retired each year), then the ITAME at the end of five years would be just 56 percent, indicating that the data center is operating at only 56 percent of the capacity it would have if all the servers were new. In comparison, if IT equipment is on a three-year refresh cycle and the oldest third of the server population is replaced each year, ITAME after three years would be 73.4 percent.

ITAME can have a significant impact on the number of servers required to do the same amount of IT work. For example, in a data center with 1,000 servers, switching from a five-year depreciation schedule to a three-year schedule can reduce overall server count to 763—a 24 percent reduction. By avoiding the installation of these physical servers, the organization in this example scenario could expect to emit about 24 percent less CO_2 than if it were using a five-year depreciation schedule. This approach can also lead to savings on data center power, cooling, space, and administration overhead.

The next metric, ITUE, describes the ability of servers to convert electricity into IT work, defined as processor utilization divided by power consumption as a percentage of total possible power consumption. Energy use by servers does not increase at the same rate ITUE increases, indicating that servers have the capacity to perform more work per unit of energy used (see Figure 2). Underutilization of IT equipment can be one of the most significant sources of inefficiency in the data center. Because virtualization is designed to increase resource utilization, it can help significantly boost ITUE.

Finally, the ITE metric quantifies the relative efficiency with which IT hardware such as servers and storage devices convert energy into useful IT work; the hardware with the lowest power consumption at a specific desired configuration is defined as having an ITE of 100 percent. Not all IT equipment uses the same amount of electricity to perform IT work, and the differences between hardware from different vendors can be significant. Dell helps to address ITE by focusing on Dell Energy Smart technologies within its server and storage product families.



Note: Power consumption based on a curve fit of measurements performed on a two-socket Dell PowerEdge 2950 server as part of a Dell Server Performance Analysis lab study, November 2007; for more information, see "Best Practices for Unlocking Your Hidden Data Center," in *Dell Power Solutions*, February 2008, DELL.COM/Downloads/Global/Power/ps1q08-20080198-Esser.pdf.

Figure 2. *ITUE values as processor utilization increases, showing how virtualization can be a major contributor to efficiency*

Step 3: Take action

After IT leaders have established the baseline values for energy use and applied this methodology to assess the data center's overall efficiency, they can take a variety of measures to enhance efficiency in specific areas. By reducing or eliminating power consumption in targeted areas and converting to renewable energy sources wherever possible, IT executives encourage sustainable growth and can significantly boost the bottom line—often with improving service levels for vital business processes.

Several strategies, used alone or in combination, help advance data center efficiency:

- **Refresh data center hardware:** Typically, IT equipment is used for five years or longer. Assuming that the server infrastructure leverages virtualization technologies, reducing the server lifetime to three years can produce significant

> **"Green IT equals efficient IT—and that equals an efficient and sustainable enterprise with a healthy bottom line."**

savings in total server acquisition and maintenance costs because of the efficiencies realized by more recent server technology. For example, the multi-core Intel Xeon processor 5500 series in 11th-generation Dell PowerEdge servers is designed to provide up to 2.25 times the performance of the Intel Xeon processor 5400 series in a similar power envelope[1] while consuming less idle and peak power, helping to maximize performance, optimize energy use, and enable dramatic reductions in server count for the same amount of processing power.

- **Virtualize to increase utilization:** IT equipment in traditional data centers typically runs at only a fraction of its capacity. At this level, servers are extremely inefficient at converting electricity into IT work—but increasing that utilization can lead to major increases in efficiency. For example, as shown in Figure 2, going from 10 percent processor utilization (a typical level in non-virtualized environments) to 40 percent utilization (typical of virtualized environments) on a typical two-socket, 2U server can increase the IT work output of that server by a factor of four while only consuming 17 percent more power—resulting in a more than threefold increase in ITUE, with the accompanying reductions in power consumption, operating costs, and CO_2 emissions. Dell PowerEdge servers with the Intel Xeon processor 5500 series can utilize Intel Virtualization Technology to significantly increase virtualization performance, further enhancing the efficiency benefits of virtualization.
- **Avoid the cost of building new data centers:** By upgrading their facilities and IT equipment, organizations can dramatically increase the efficiency of their existing data center and potentially avoid the massive cost of building a new one. Investing in these upgrades following the approach described in this article can yield a rapid ROI—even in as little as 12 months, depending on the specific environment. And by taking advantage of power and temperature data accessed through instrumentation in 11th-generation Dell PowerEdge servers with the Intel Xeon processor 5500 series, organizations can also manage facility-level power and cooling based on the actual requirements of the IT equipment, helping significantly reduce operational costs.
- **Update facilities:** Moving a data center from a "typical" DCiE value of 50 percent to a "better" value of 70 percent, as defined in Figure 1—for example, by investing in improvements to existing power and cooling systems or by deploying new, state-of-the-art systems—can offer an immediate and significant improvement in IT efficiency.

MAXIMIZING EFFICIENCY THROUGH GREEN IT STRATEGIES

This Dell methodology shows that green IT equals efficient IT—and that equals an efficient and sustainable enterprise with a healthy bottom line. Through three key steps, CIOs can help their enterprises get on the path to green IT and enhanced data center efficiency. Evaluating energy use through an energy audit helps establish a baseline for future improvements. Using the Total Data Center Efficiency approach to examine the organization's policies affecting green efficiency is designed to suggest specific actions organizations can take to improve their overall data center efficiency. And taking action to enhance efficiency and avoid building new data centers—particularly by refreshing systems to gain the advantages of 11th-generation Dell PowerEdge servers with the Intel Xeon processor 5500 series—helps IT executives achieve both reduced GHG emissions and significant cost savings.

Albert Esser, Ph.D., is the CEO and founder of Econdius LLC, a company focusing on green IT, sustainable energy technology solutions, and technology management consulting and services. Previously, Albert served as vice president for data center infrastructure at Dell, where he was responsible for enhancing Dell's enterprise-class IT solutions by sharing insights gained from customers with the company's server, storage, data center solutions, and services teams. Albert has an M.S. and a Ph.D. in Electrical Engineering from the University of Aachen. He holds 12 U.S. patents.

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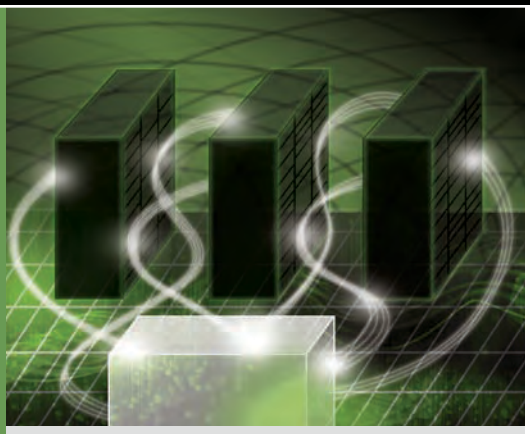
[1] Based on Intel internal measurements in February 2009; for more information, see "Intel Xeon Processor 5500 Series: An Intelligent Approach to IT Challenges," by Intel, www.intel.com/assets/pdf/prodbrief/321579.pdf. Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance. Buyers should consult other sources of information to evaluate the performance of systems or components they are considering purchasing. For more information on performance tests and on the performance of Intel products, visit www.intel.com/performance/resources/limits.htm.



REDUCING POWER CONSUMPTION WITH DELL/EMC CX4 SERIES STORAGE

By Annette Cormier
Rodan Zadeh

Rising energy costs and growing volumes of information mean that pressure is mounting to increase the efficiency of storage systems and reduce power consumption. Employing capabilities such as disk drive spin-down, virtual provisioning, and tiered storage design in Dell/EMC CX4 Series storage arrays helps IT organizations keep energy costs under control.

Energy-efficient storage has become an imperative for IT organizations. The tremendous growth of storage, spurred by government mandates and an explosion of data, means that overall IT costs are going up. Energy is a significant part of that increase—the cost of power and cooling has been steadily rising with no downturn in sight. The availability of energy is also a challenge. At the same time that increasing resources are needed to retain and manage data, many data centers are running out of power capacity and sources of supply.

These challenges, along with important environmental initiatives, are pressing IT managers to define a clear strategy for reducing storage power consumption. Dell/EMC CX4 Series storage area network (SAN) arrays offer compelling options designed to reduce power consumption and cooling requirements.

DEVELOPING A MULTIFACETED APPROACH TO ENERGY USE

Today, administrators grapple with a number of approaches that can be used together or as stand-alone measures to address power and cooling problems. IT organizations need a comprehensive array of tools that enable them to implement the most appropriate way to suit their specific storage and energy requirements. For that reason, Dell/EMC CX4 Series SAN arrays offer multiple capabilities and options together in a single system. Energy efficiencies specific to Dell/EMC CX4 Series storage include the following:

- **Disk drive spin-down technology:** Because much of the energy use in a given array goes into keeping mechanical drives spinning, whether they are being used or not, disk drive spin-down can provide the most direct way of reducing energy use at the source.
- **Virtual provisioning:** This flexible, automated approach to capacity utilization can enhance energy efficiency by increasing utilization rates and deferring the use of additional capacity.
- **Enterprise flash drives (EFDs):** The benefits of solid-state technology in EFDs—including no moving mechanical parts and no rotating platters—help to reduce power consumption and increase performance for critical applications.
- **Low-power Serial ATA (SATA) II drives:** These drives, designed for archiving and backup to disk, can help significantly reduce storage power consumption and can therefore be excellent candidates for offline content.
- **Adaptive cooling:** Intelligent automation that adjusts blower and fan speeds based on system activity helps reduce energy use.
- **Virtual logical unit (LUN) migration:** Efficient management of storage tiers and the ability to move between the tiers is transparent to the hosts.

Each of these features can play a valuable role in helping organizations conserve power and optimize data center efficiency.

Disk drive spin-down technology to help reduce energy use

Integrated functionality in Dell/EMC CX4 Series arrays is designed to enable disk drive spin-down capabilities for applications that require infrequent access to data. The Dell/EMC CX4 Series allows administrators to set policies at the RAID group level to place inactive drives in sleep mode after they have been idle for a set amount of time. The platform is designed to allow the drives to spin down the drive motor to 0 rpm but still keep the electronic capabilities in the drive powered up, enabling it to respond quickly to I/O. IT administrators can also monitor disk drive spin-down states using EMC® Navisphere® Management Suite software.

Virtual provisioning to enhance utilization rates

Dell/EMC CX4 Series arrays provide virtual provisioning to enhance energy efficiency by increasing utilization rates and deferring the use of additional capacity. IT managers have traditionally met application performance and availability requirements by preallocating enough physical storage capacity to handle anticipated growth, which often means unutilized physical capacity is running and consuming power.

Instead of overprovisioning hardware, organizations can help save operating expenses, including energy costs, by deploying additional storage only as needed (see Figure 1). Virtual provisioning in Dell/EMC CX4 Series arrays offers a thin provisioning–based storage virtualization technology that aggregates thin LUNs into a virtualized thin pool of shared storage capacity. The system then allocates physical capacity on demand, automatically.[1]

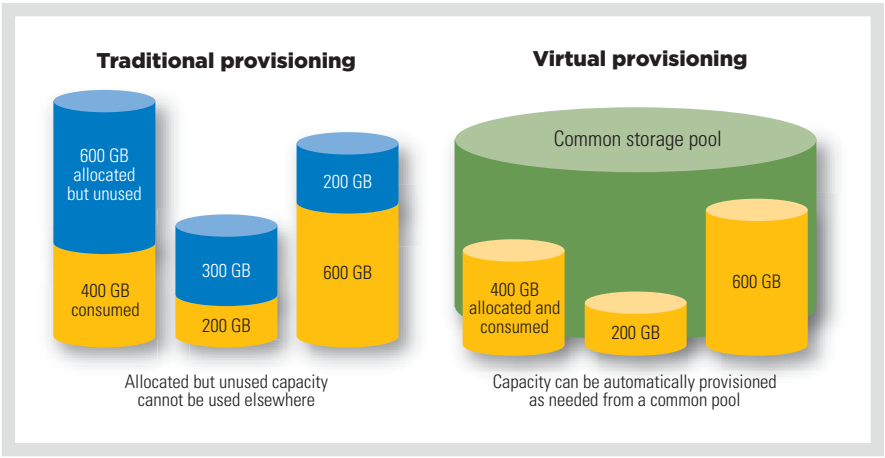


Figure 1. *Comparing capacity requirements for traditional provisioning and virtual provisioning*

EFDs to deploy flash technology in storage environments

Dell/EMC CX4 Series storage provides the option of including EFDs in the arrays. Depending on specific application environments, such as those with high transaction rates, a single EFD can achieve similar performance levels to multiple 15,000 rpm Fibre Channel drives, but require up to 98 percent less energy consumption per I/O per second (IOPS) than traditional disk drives. By avoiding mechanical overhead and data placement latency, EFDs can enhance application performance as well as efficiency.[2]

Low-power SATA II drives to help reduce power consumption

Low-power 5,400 rpm SATA II drives in Dell/EMC CX4 Series arrays are designed to maximize power savings for large, high-capacity deployments such as array-based backup to disk, online tape replacement, data warehousing, and test and development. These drives are designed for applications in which low energy use and cost-to-performance ratio is important and high performance is not a priority. They can use up to 96 percent less energy per terabyte than 73 GB, 15,000 rpm Fibre Channel drives and 32 percent less energy than traditional 1 TB, 7,200 rpm SATA drives.[3]

Adaptive cooling to help monitor storage environments

The Dell/EMC CX4 Series provides adaptive cooling functionality that uses intelligent sensor technology to monitor airflow and temperature within the storage array. Adaptive cooling is designed to adjust blower and fan speeds based on system activity to help reduce power consumption for cooling, because the blower and fans operate only when needed.

Virtual LUN migration to help efficiently manage tiered storage

The virtual LUN migration capability available in Dell/EMC CX4 Series arrays allows data migration to take place dynamically and effortlessly, helping to avoid disruption in tiered storage environments where data frequently moves between tiers. Dell/EMC CX4 Series storage also supports the optional EMC MirrorView™ and EMC SAN Copy™ data replication and migration tools, which enable remote mirroring of data from one array to another.

[1] For more information on virtual provisioning in Dell/EMC CX4 Series storage, see "Allocating Storage with Virtual Provisioning on Dell/EMC CX4 Series Storage Arrays," by Greg White, Annette Cormier, and Eric Cannell, in *Dell Power Solutions*, September 2009, DELL.COM/Downloads/Global/Power/ps3q09-20090397-Cannell.pdf.

[2] For more information on EFDs in Dell/EMC CX4 Series storage, see "Boosting Performance with Enterprise Flash Drives in Dell/EMC CX4 Series Storage," by Bharath Vasudevan, Annette Cormier, and Eric Cannell, in *Dell Power Solutions*, September 2009, DELL.COM/Downloads/Global/Power/ps3q09-20090393-Cormier.pdf.

[3] Based on drive specifications; actual power consumption will vary based on configuration, usage, and manufacturing variability. For more information and a detailed analysis of performance characteristics and differences between 1 TB, 5,400 rpm SATA II drives and 1 TB, 7,200 rpm SATA II drives, see "An Introduction to Dell/EMC Storage Device Technology," by Dell Inc., April 2009, available at DELL.COM/EMC.

	Storage type	Disk drive
Tier 1a	Logs	73 GB, 4 Gbps EFD 200 GB, 4 Gbps EFD 400 GB, 4 Gbps EFD
Tier 1b	Hot data, tables	146 GB, 15,000 rpm, 4 Gbps Fibre Channel 300 GB, 15,000 rpm, 4 Gbps Fibre Channel 450 GB, 15,000 rpm, 4 Gbps Fibre Channel
Tier 2a	Warm data, tables	450 GB, 10,000 rpm, 4 Gbps Fibre Channel 600 GB, 10,000 rpm, 4 Gbps Fibre Channel
Tier 2b	Clones	450 GB, 10,000 rpm, 4 Gbps Fibre Channel 600 GB, 10,000 rpm, 4 Gbps Fibre Channel
Tier 3	Backup to disk, archive	1 TB, 5,400 rpm, low-power SATA II 1 TB, 7,200 rpm, low-power SATA II

Figure 2. *Configuring Dell/EMC CX4 Series arrays in an example tiered storage configuration*

CREATING A TIERED STORAGE STRATEGY

One answer to the explosion of data in today's data centers is information life cycle management (ILM), a best-practice approach for utilizing a variety of storage tiers with different performance and energy use characteristics to help reduce costs. As active use of aging data decreases, the data can be moved to an appropriate storage tier where it can remain online and accessible. ILM can lead to measurable cost-efficiency for energy because data can be moved to a least-energy-intensive tier.

Dell/EMC CX4 Series arrays offer the ability to implement multiple tiers of storage using a variety of disk drive technologies and corresponding energy requirements within the same array. Mixing drives involves balances and trade-offs. For example, deploying a SATA drive with a low rotational speed can mean a trade-off in performance but enhanced energy efficiency, which can be appropriate for data that is not used often. The following three types of drives are available in Dell/EMC CX4 Series arrays to help facilitate storage tiers:

- **EFDs:** Designed to use much less energy than other drive types, EFDs can be especially well suited for low-latency applications that require consistently low (under 1 ms) read/write response times. Because performance is typically application dependent, EFDs should be matched to the application to help optimize cost-effectiveness.
- **Fibre Channel drives:** Available with either 10,000 rpm or 15,000 rpm rotational speeds, Fibre Channel drives can be appropriate for environments running applications that require large capacities and high performance.
- **SATA drives:** SATA drives can be an energy-efficient choice in modest-performance environments, and can also provide cost-effective, energy-efficient bulk storage capacity. Dell recommends using SATA II drives for single-threaded, large-block streaming applications.

Organizations can apply different capacity and performance drives, RAID types, and enclosures to suit various applications within an operating environment. Disk drives for Dell/EMC CX4 Series arrays are available in a range of capacity points and spindle speeds, which may be factored into the mix. Figure 2 provides one example of how drives may be configured for storage tiers.

OPTIMIZING ENERGY EFFICIENCY FOR DELL/EMC CX4 SERIES STORAGE

As organizations look to reduce energy use in their data centers, enterprise storage systems can be a significant focus of the efforts to reduce power consumption. Dell/EMC CX4 Series storage systems can efficiently handle demanding applications while offering multiple options that help reduce energy use. Features such as disk drive spin-down technology and virtual provisioning, as well as capabilities such as tiered storage using Dell/EMC CX4 Series SANs, can help organizations meet their environmental goals and maintain control of energy costs. Organizations using techniques such as tiered storage that incorporate EFDs and low-power disk drives can achieve favorable data center efficiency to help mitigate increases in energy costs and the ongoing challenge of power availability.

Annette Cormier is a solutions marketing manager for Dell/EMC storage solutions. She has 20 years of experience in developing and bringing to market enterprise storage, network management, and security products for Dell, Hewlett-Packard, and SGI. Annette has a B.S. in Computer Science, Artificial Intelligence, from Colorado State University.

Rodan Zadeh is a consultant marketing manager for midrange storage platforms at EMC. He has a B.S. in Electronics Engineering from California State University and an M.S. in Management from the Massachusetts Institute of Technology's Sloan School of Management.

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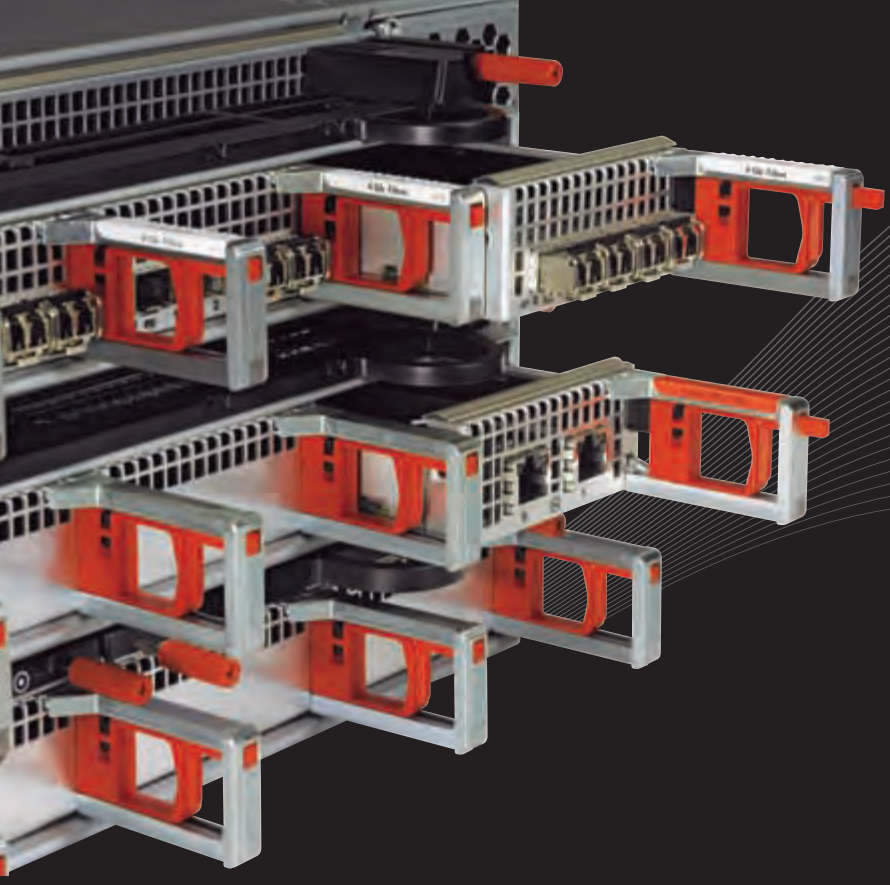

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INCREASING STORAGE EFFICIENCY WITH COMMVAULT'S SINGULAR APPROACH TO DATA MANAGEMENT

By Darin Camp

As enterprises contend with increasing amounts of data, effective data management can become critical to success. The CommVault® Simpana® platform offers an efficient, singular approach to data management, helping to increase storage efficiency, eliminate redundant copies of data, and reduce power, cooling, and space requirements across the organization.

Energy-efficient, environmentally conscious IT strategies are becoming increasingly important in enterprise data centers—not only as a matter of social responsibility toward global ecosystems, but also as a sound business decision. The explosion of data growth coupled with inefficient data management practices can put a tremendous strain on IT resources. The need to support unmanaged, redundant copies of data spread across the enterprise, for example, contributes to rising storage acquisition costs and increasing power, cooling, and space requirements in the data center. Meanwhile, increasingly constrained IT budgets mean that the traditional approaches of simply adding hardware and software to support existing and emerging business applications may be impractical.

Implementing effective data management can help create measurable increases in consumption efficiency and performance while helping minimize operational costs both today and in the future. (For more information on recommended best practices to help maximize efficiency, see the "Best practices: 5 policies for efficient data management" sidebar in this article.) The Singular Information Management® approach offered by the CommVault Simpana platform, included in the Dell™ PowerVault™ DL2100 – Powered by CommVault, can play a key role in these strategies—helping to increase storage efficiency, eliminate redundant copies of data, and reduce power, cooling, and space requirements across the enterprise.

DATA SPRAWL AND RISING COSTS

As data growth continues to skyrocket, effective storage and data management strategies become critical to success. Although technologies such as virtualization and consolidation can help reduce the data center footprint, they do not address a fundamental problem—poor data management tools that make it difficult or impossible to gain visibility into data dispersed across the enterprise, leading to inefficient, wasteful use of storage resources.

Figure 1 illustrates the compounded impact that inefficient data management can have on storage requirements. In this scenario, a single object (such as a file or e-mail) is stored and then shared with 9 people, leading to 10 total copies of the file. The object is subsequently archived, which moves these 10 copies and utilizes no additional storage. When the 10 archived copies are then backed up to disk, however, the total rises to 20 copies. If these 10 copies are also replicated, the result is a cumulative total of 30 copies of the object on disk—all consuming storage capacity as well as the associated power, cooling, and space in the data center simply to store dozens of copies of the same data.

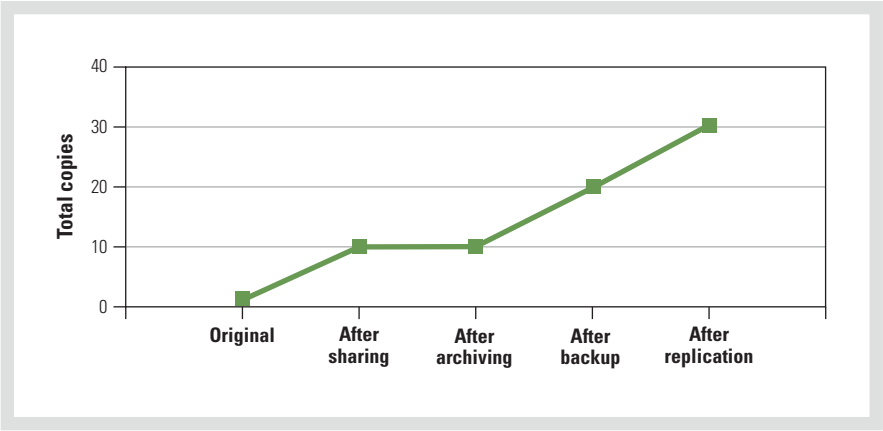

Figure 1. *Unnecessary copies of a single file resulting from inefficient data management*

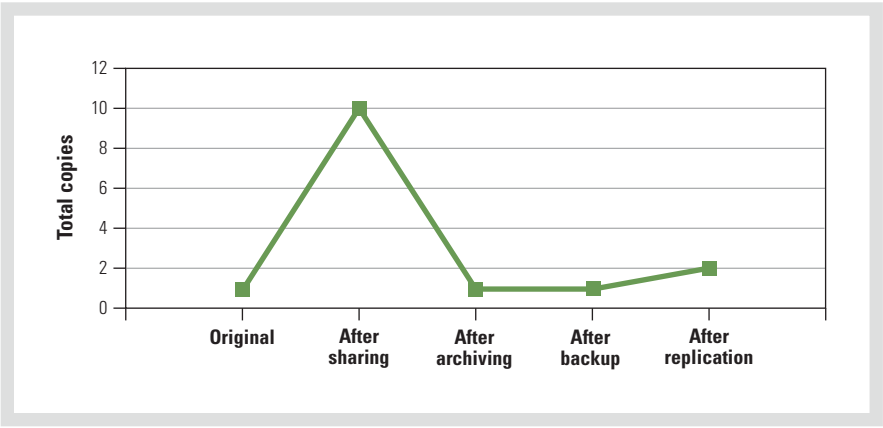

Figure 2. *Efficient use of storage resources with the CommVault Simpana singular approach to data management*

BEST PRACTICES: 5 POLICIES FOR EFFICIENT DATA MANAGEMENT

Adhering to best practices such as the following can help enterprises maximize data management efficiency in their IT infrastructures:

1. Audit enterprise data populations and assess enterprise data storage capacity utilization.
2. Establish a strategy to help maximize data resources and capacity management, and to minimize associated consumption and costs.
3. Consider tools that can help reduce data redundancy and streamline storage capacity utilization.
4. Target solutions offering measurable cost efficiencies.
5. Evaluate IT infrastructure and labor spending reductions, as well as associated reductions in data center energy demands.

COMMVAULT SIMPANA COMMON PLATFORM

Eschewing the inefficient, traditionally siloed approach to data management, CommVault Simpana software employs licensable modules for backup, archiving, replication, resource management, and search—all built from the ground up on a single unifying code base and common platform. This truly integrated data management system offers a way to effectively manage data scattered across the enterprise while helping reduce power, cooling, and space requirements. After running reports and analyzing the results, administrators can create tiered storage policies to help optimize storage utilization and reduce operational costs.

Using the CommVault Simpana platform can help eliminate the redundant backup, archiving, and replication data typically stored across disparate applications, servers, and storage systems. Figure 2 illustrates how this approach to data management can help significantly reduce storage requirements. While Figure 1 showed how a single object could easily become 30 copies, in this example, CommVault deduplication helps ensure that when the object is archived, only 1 copy is stored on disk, rather than 10. Because the object has already been processed through the deduplication engine, this same copy is retained (and not duplicated) for backup purposes; if the object is replicated, a second copy is created. The total cumulative number of copies retained on disk is just 2—compared with 30 in the scenario shown in Figure 1. Across many terabytes of data, this highly efficient way of storing data can dramatically reduce total storage requirements.

CommVault Simpana software enables organizations to choose the backup and recovery, replication, archiving, resource

> **"Using the CommVault Simpana platform can help eliminate the redundant backup, archiving, and replication data typically stored across disparate applications, servers, and storage systems."**

> **"Implementing effective data management can help create measurable increases in consumption efficiency and performance while helping minimize operational costs both today and in the future."**

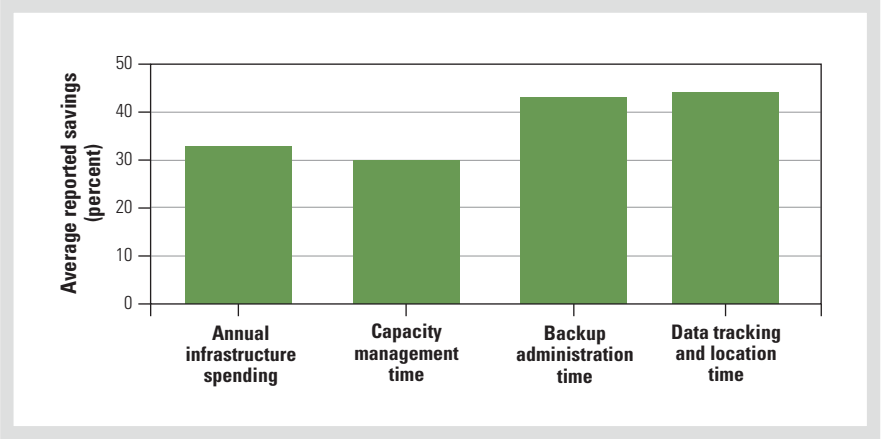

Figure 3. *Average CommVault cost and time savings (among those reporting savings)*

management, and/or search modules that meet their current needs, and offers the flexibility to activate additional modules as those needs change. Because CommVault applications utilize a single technology platform, each aspect of the solution can take advantage of a common set of data and information management services, including content indexing, deduplication, compression, encryption, and reporting. The result is comprehensive visibility into data stored across the enterprise, helping administrators to store data on appropriate storage tiers and eliminate unnecessary data duplication. And by helping organizations make efficient use of existing resources, CommVault Simpana software can also help reduce or postpone the need to purchase and deploy new storage systems—contributing to reduced power, cooling, and space requirements.

To assess typical return on investment across multiple aspects of IT infrastructures and operations, in March 2008 CommVault conducted an online survey of its customers and had the results independently validated by industry analysts Enterprise Management Associates. The survey findings repeatedly draw a connection between CommVault's singular approach to data management and enhanced efficiency, performance, and return on investment.

Figure 3 illustrates some of the aggregated results from this survey. In terms of spending, nearly two-thirds of the respondents reported a savings in at least one area of infrastructure spending (hardware and/or software), with an average 33 percent reduction in areas where savings were reported. Over three-fourths of the respondents reported significant reductions in time spent on weekly backup administration and time spent tracking and locating data, with a weighted average reduction of 42 percent and 44 percent, respectively, among those reporting a reduction. A smaller percentage reported saving time on capacity management, but those who did saved a weighted average of 35 percent. The associated decrease in reported IT administration time was 10 hours per week.[1]

EFFICIENT DATA MANAGEMENT PRACTICES

CommVault is dedicated to developing energy-efficient enterprise solutions. A principal component of this commitment, for example, is participation in The Green Grid (www.thegreengrid.org), an international consortium focused on improving energy efficiency in business IT infrastructures through platform-neutral standards and metrics. The CommVault Simpana data and information management platform is also designed around this commitment—helping organizations to maximize power, cooling, and space efficiency in their data centers; increase operational performance; and reduce overall IT costs.

Darin Camp is a senior technical alliance manager at CommVault, and has spent the past 12 years in the storage networking and data protection industries.

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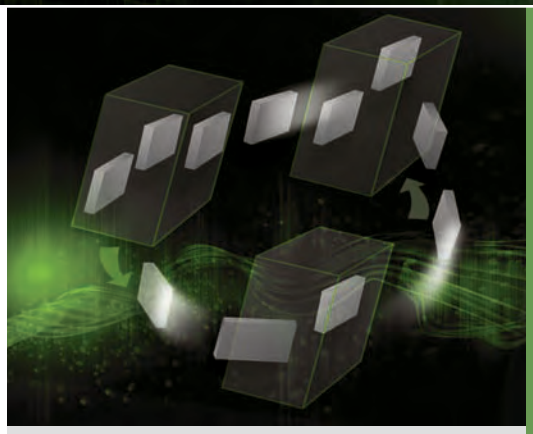
[1] For additional results and survey details, see "CommVault Customer Survey: Data Validation and User ROI," by Enterprise Management Associates, Inc., July 2008, dell.commvault.com/files/EMA_CommVault-CustomerSurvey_WP.pdf.

HIGH-EFFICIENCY DELL UPS MODELS FOR VIRTUALIZED ENVIRONMENTS



By William Muscato

Virtualization introduces multiple challenges for power protection infrastructures in enterprise data centers. Small and midsize Dell™ uninterruptible power supply (UPS) models are designed for virtualized environments, helping organizations maintain the availability of critical systems while maximizing overall data center efficiency.

Virtualization has the potential to deliver dramatic savings in enterprise data centers—helping to consolidate servers and reduce overall power consumption, cooling requirements, and physical footprint. However, virtualized environments can also introduce significant challenges for the power protection infrastructure. Although an existing infrastructure may have been sufficient for a traditional data center, it could easily be inadequate to meet the flexible, shifting performance patterns common to virtualized environments.

Dell uninterruptible power supply (UPS) models offer a practical, cost-effective way to address these challenges while helping further increase efficiency. By understanding the specific demands of virtualized environments, utilizing key features of Dell UPS models and Dell UPS Management Software, and adhering to best practices for choosing an appropriate UPS size, topology, and form factor, data center managers can create an efficient power protection infrastructure that can help them maintain the availability of critical workloads and realize the energy-saving potential of virtualization.

POWER CHALLENGES OF VIRTUALIZATION

For all its advantages in energy savings, virtualization does present several specific power challenges:

- **Server and enclosure power consumption rises:** Although server consolidation through virtualization helps reduce overall data center power consumption, these environments also tend to use more powerful servers that spend more time running at or near peak performance compared with non-virtualized environments—meaning that the individual servers typically draw more power than they did previously. Similarly, virtualized environments tend to concentrate power consumption per unit of rack space and per enclosure.
- **Individual servers become increasingly critical:** Because each virtualized server supports multiple virtual machines (VMs), a power problem for a single server can cause issues for an array of applications simultaneously. Power redundancy and quality—as well as cooling systems—for these servers can be critical.
- **Rack densities may exceed UPS capacity:** Virtualization often results in higher rack densities than the data center was originally designed for. The capacity of the centralized UPSs common in traditional designs can become a bottleneck, especially as redundancy becomes increasingly important.
- **Energy demands can change rapidly:** The ability to deploy, move, or clone VMs across hardware platforms means that energy demands can quickly shift—yet power is a fixed asset tied to a physical

infrastructure. On-demand migration requires enhanced visibility into how IT systems affect the power infrastructure and vice versa.

- **Efficiency may be suboptimal even with a reduced footprint:** Even in a consolidated data center, legacy UPS models may be dissipating a substantial amount of power as heat. As controlling energy use and costs becomes increasingly critical, data center managers should examine the efficiency of every aspect of the infrastructure, including their UPSs.

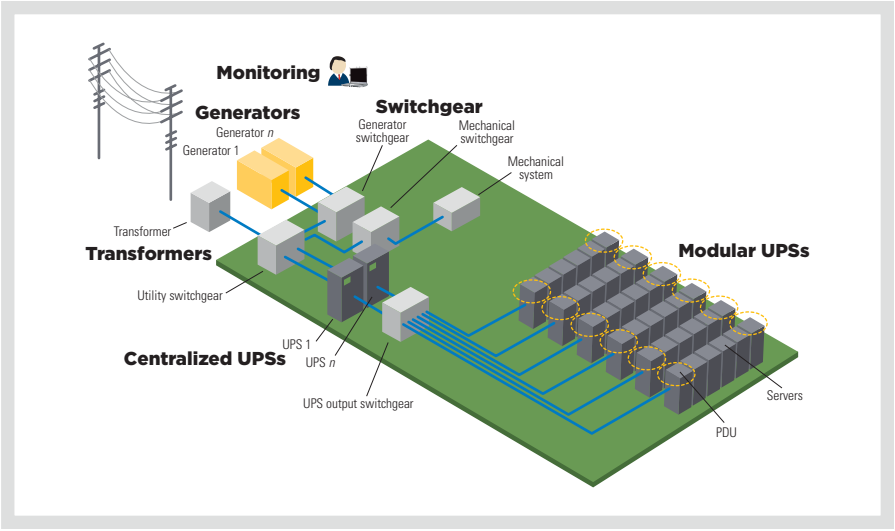


Figure 1. *Dell UPS models are well suited for supporting serial redundancy downstream from a centralized UPS*

DELL UPS MODELS IN VIRTUALIZED DATA CENTERS

Dell UPS models can help IT managers meet the power challenges of virtualized environments—including helping them to bring power protection close to servers using serial redundancy; ensure power quality and availability for redundant power sources; extend server runtime during power outages; provide increased visibility into power conditions at the row, enclosure, and server levels; remotely monitor and manage enclosure-level power; remotely shut down and reboot VMware® virtualized servers; and extend the gains of virtualization through highly efficient UPS designs.

Bringing power protection close to servers

Data centers are typically protected by a large, centralized UPS that provides conditioned power and battery backup to the entire data center. But if a problem arises with that centralized UPS, it would then switch to bypass mode, and raw utility power would be passed directly to IT equipment.

Virtualized servers are often too critical to be subjected to the anomalies common in utility power. In this case, IT staff can deploy small or midsize UPS models at the row, enclosure, or server level. Rack-mount UPS models can be installed in the same enclosure as the virtualized servers they protect, in nearby enclosures, or at the end of the row, with power sent to enclosures through a power distribution unit (PDU). In addition, small organizations that do not have a centralized UPS can deploy small or midsize UPS models close to the protected loads that can provide appropriate capacity ratings, efficiency ratings, and form factors for the environment. In the configuration shown in Figure 1, the large UPS is the first line of defense, receiving utility power and sending conditioned power to its protected loads. Small or midsize UPS models installed in the rows help provide an additional layer of protection—which can be especially important if the central UPS is offline.

Maintaining power quality and availability

Virtualized servers typically have dual power supplies at a minimum, which helps protect the applications on that server if one power supply should fail. To help maximize this protection, these redundant power supplies should also receive their power from separate sources, each protected by an independent local UPS. Each UPS would then help protect one power path to the server hardware and share the load. If one UPS or its input power source fails, the other UPS can take over without dropping the load.

Extending server runtime during power outages

Dell UPS models have internal batteries designed to keep servers running for approximately 5–8 minutes during a power outage when the UPS is fully loaded.[1] If the UPS is lightly loaded, then this runtime can extend accordingly, potentially enabling the server to continue running through a short outage or giving IT staff an opportunity to gracefully shut down applications and servers in anticipation of a long outage.

In virtualized environments, however, it may be desirable to keep servers running through outages of 30 minutes or more, to avoid the burden of shutting down and restarting a large number of critical applications. Dell UPS models offer two options for extending battery runtime:

- **External battery modules (EBMs):** EBMs are deployed in a separate enclosure. Most Dell UPS models rated in the 1,000–5,600 W range support an optional EBM designed to extend

[1] Based on tests performed by Eaton Corporation in May and June 2009 on Dell UPS models under 100 percent load; actual runtime will vary based on configuration and usage.

runtime to 14–25 minutes at 100 percent load and to 35–85 minutes at 50 percent load, depending on the UPS model.[2]

- **Selective shutdown:** The load-segments feature enables administrators to selectively shut down power for one or more groups of outlets on the back of the UPS. During a power outage, they could shut down power to noncritical servers to help extend the battery backup time for critical servers. This capability can also help extend overall battery life and, in turn, delay the costs of battery replacement.

> **"Dell UPS Management Software enables network managers to remotely monitor and manage Dell UPS models."**

Increasing visibility into power conditions

In virtualized environments, power consumption can fluctuate with every reallocation of applications—meaning that it is no longer enough to see power conditions at the main switchgear level through power quality and event data delivered by the centralized UPS. Dell UPS models, working with Dell UPS Management Software, can deliver a wealth of information about power consumption, power events, available battery runtime, alarm conditions, and more (see Figure 2). Administrators can use this software to obtain detailed, aggregated information that they can use to prevent tripped circuits, understand where new systems and applications can be deployed, balance loads, and diagnose power problems.

Remotely monitoring and managing enclosure-level power

Dell UPS Management Software enables network managers to remotely monitor and manage Dell UPS models. A network management card provides a gateway for remote communications with an IT or facility monitoring and management system over a local area network (LAN) or wide area network (WAN) and the Internet. The managers can monitor and configure Dell UPS models from virtually any system equipped with a network management card and the appropriate authorization and connectivity. The software maintains logs of relevant power information, including utility power, UPS status, UPS load, and battery status in a single window. Administrators can even run Dell UPS Management Software as a virtualized application in VMware ESX 3.5 VMs.

Remotely shutting down and rebooting virtualized servers

Dell UPS Management Software enables orderly, unattended shutdown of protected servers during power outages. Organizations can potentially protect hundreds of devices in remote or unmanned sites without requiring on-site visits from a technician. Administrator-defined sequencing of outlets and time delays permits controlled remote server boots, while virtual groupings of outlets permits single-click reboots of multicorded servers, entire racks, or noncritical loads. The latest version of the software can display all IT equipment powered by a given UPS—including VMware virtualized servers—and enable connected servers and VMs to be shut down in their normal fashion, including saving work up to the moment of shutdown.

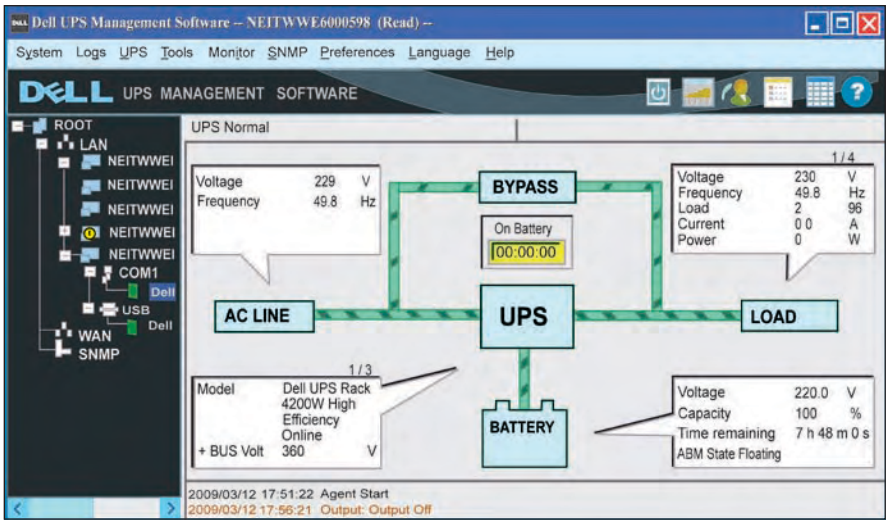


Figure 2. *Dell UPS Management Software can provide detailed, aggregated information on UPS status and events*

Extending the efficiency gains of virtualization

Virtualization efficiency can be extended even further through the UPS models that help protect the virtualized servers. Small and midsize Dell UPS models are rated for up to 96 percent efficiency under normal operating conditions,[3] helping avoid excessive heat dissipation that not only increases power costs but also places additional burdens on cooling systems. When an online UPS must work to overcome poor power conditions, this efficiency can be somewhat lower, but the UPS can then return to a highly efficient state of operations when

[2] Based on tests performed by Eaton Corporation in May and June 2009 on Dell UPS models with EBMs under 100 percent and 50 percent loads; actual runtime will vary based on configuration and usage.

[3] Based on product specifications; actual efficiency will vary based on configuration and usage.

Form factor	Rated power capacity	EBM available	Rack space	Topology
Tower	500 W	No	N/A	Line interactive
Tower	1,000 W	Yes	N/A	Line interactive
Tower	1,920 W	Yes	N/A	Line interactive
Tower or rack mount	2,700 W	Yes	3U	Line interactive
Rack mount	1,000 W	No	2U	Line interactive
Rack mount	1,920 W	Yes	2U	Line interactive
Short-depth rack mount	2,700 W	Yes	4U	Online
Rack mount	3,750 W	Yes	4U	Online
Rack mount	4,200 W	Yes	4U	Online
Rack mount	5,600 W	Yes	4U	Line interactive
Rack mount	5,600 W	Yes	4U	Online

Figure 3. *Small and midsize Dell UPS models offer a variety of size ratings, topologies, and form factors*

power conditions are back within acceptable parameters.

BEST PRACTICES FOR CHOOSING A UPS

Choosing an appropriate UPS requires consideration of several factors, including the size rating, topology, and form factor. The small and midsize Dell UPS portfolio includes a range of models to help meet different needs (see Figure 3). For example, these Dell UPS models offer rated power capacities from 500 W up to 5,600 W to enable a close match of UPS to specific requirements. Because a UPS is typically less efficient at reduced loads, administrators should generally select an appropriately sized UPS and run it at a high utilization, rather than using a large, underutilized UPS.

Many UPS models are also rated by volt-amperes (VA), but that can be a confusing figure—the VA rating represents apparent power, while the W rating represents the real value available to servers. The relationship between the W and VA ratings is a function of the UPS's power factor. Dell UPS models are power factor corrected, which means that the W and VA ratings are equivalent, but this is not necessarily true of UPS models from other vendors—a UPS with a power factor of .7 might be rated for 1,000 VA but only able to deliver 700 W of usable power.

A general guideline for choosing an appropriate UPS size is to add up the total IT equipment load in watts, allow for 20 percent growth, and select a UPS that can comfortably handle that load. For example, in an environment with a 900 W load, a Dell UPS model rated for 1,000 W would generally be an appropriate choice.

In addition to size, topology can also be an important consideration. Are energy efficiency and low total cost of ownership paramount? Or are the applications so critical that they require premium power protection? A line-interactive UPS can provide efficient protection against outages, sags, surges, brownouts, and over-voltage conditions, while an online UPS can help protect against all nine common power problems, including harmonics and frequency variation—making this type well suited for mission-critical applications and servers.

Finally, organizations should consider the UPS form factor. High-density rack-mount UPS models can be installed in the same rack as IT equipment, while elegant tower units can fit under a desk or in an office or equipment closet. UPS models with a combined form factor use rail kits for rack mounting or a stand for tower use to help maximize deployment flexibility.

HIGH-EFFICIENCY POWER PROTECTION INFRASTRUCTURE

To successfully implement a virtualization initiative, IT teams must account for the dynamic changes in power demands, high server and rack power densities, and critical need to protect applications with sufficient UPS capacity. Dell UPS models are designed to meet these needs, enabling organizations to realize the energy-saving potential of virtualization and consolidation while helping ensure that they can meet power quality and backup requirements at the row, rack, and server levels of the data center.

William Muscato is a product manager at Dell responsible for Dell rack and power infrastructure products. He has a degree in Electrical Engineering from the Rochester Institute of Technology and an M.B.A. from the Ohio State University.

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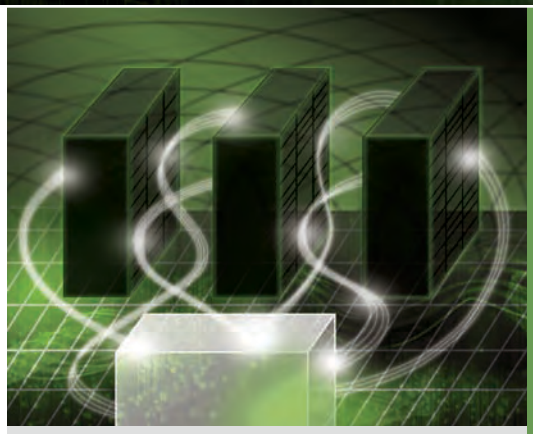
PRECISION COOLING FOR HIGH-DENSITY DATA CENTER ENVIRONMENTS



As rack densities rise, cooling systems play an increasingly critical role in protecting sensitive IT systems and maintaining system availability. Using precision cooling and the SmartAisle™ containment system from Emerson Network Power can help IT organizations efficiently handle heat loads and create a cost-effective data center infrastructure.

Cooling systems play an increasingly critical role in protecting sensitive IT systems from extreme variations in temperature and humidity that can cause system failure, degrade performance, and shorten equipment life—particularly in the high-density environments that have become common in enterprise data centers. Conventional air-conditioning, or *comfort cooling*, is typically inadequate for controlling the environmental conditions in most data centers. But by using precision cooling systems designed for data center requirements in conjunction with containment strategies using the SmartAisle system from Emerson Network Power, IT organizations can help protect critical equipment and maintain system availability while supporting efficient, cost-effective infrastructures.

COMFORT COOLING AND PRECISION COOLING

Many IT departments are still relying on comfort cooling systems for cooling IT equipment. But as rack densities increase, this approach to cooling can become highly inefficient—and expensive. To understand the difference between comfort cooling and precision cooling, and why precision cooling is generally better suited for data center environments than comfort cooling, it is important to understand their relative heat removal ratios.

Comfort cooling systems typically use 60–70 percent of their energy to reduce temperature (referred to as sensible cooling capacity) and 30–40 percent to remove moisture (referred to as latent cooling capacity). This capacity is expressed as a heat removal ratio of 0.60–0.70. Comfort cooling is well suited for environments where people gather or work, because people give off moisture.

Data centers, on the other hand, require cooling systems that address the dry heat generated by electronic equipment. Precision cooling systems are typically designed to provide a heat removal ratio of 0.85–1.0, which means that 85–100 percent of their energy is devoted to cooling rather than removing humidity (see Figure 1). When using a comfort cooling

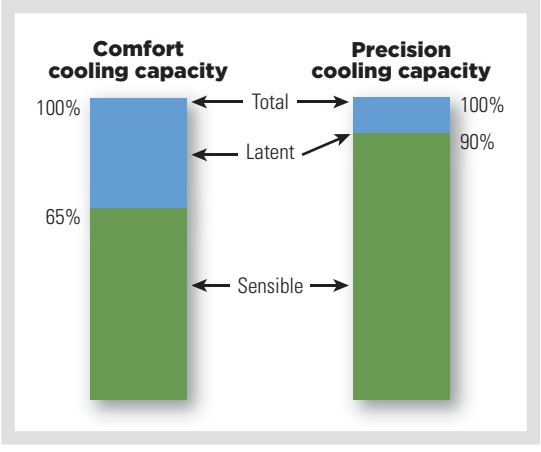


Figure 1. *Precision cooling systems are designed to efficiently remove the sensible dry heat generated by IT equipment*

system, a data center would typically require a larger unit to cool the same IT environment compared with a precision system. In general, it takes three tons of comfort cooling capacity to equal two tons of precision cooling capacity.

The heat removal ratio plays a central role in calculating annual cooling costs. In addition, the cost of re-humidification, which is necessary to avoid static electricity in the data center, pushes up the cost of using a comfort cooling system compared with a precision cooling system that has humidification control built in.

Comparing heat removal costs between comfort and precision cooling systems reveals significant operational savings for precision systems, even for relatively small data centers. For example, in a 500-square-foot data center operating at 72°F and 50 percent relative humidity, with equipment producing a heat load of 9 tons and an energy price of US$0.10/kWh, a 15-ton comfort cooling system consuming 18.5 kW of power to run the compressors and fan would cost US$1,878 per sensible ton per year to operate for heat removal alone. A 10-ton precision cooling system consuming 12.5 kW of power to run the compressors and fan, by comparison, would typically cost US$1,258 per sensible ton per year.

Liebert XDR (left) and Liebert CRV cooling systems deliver cool air close to the heat source

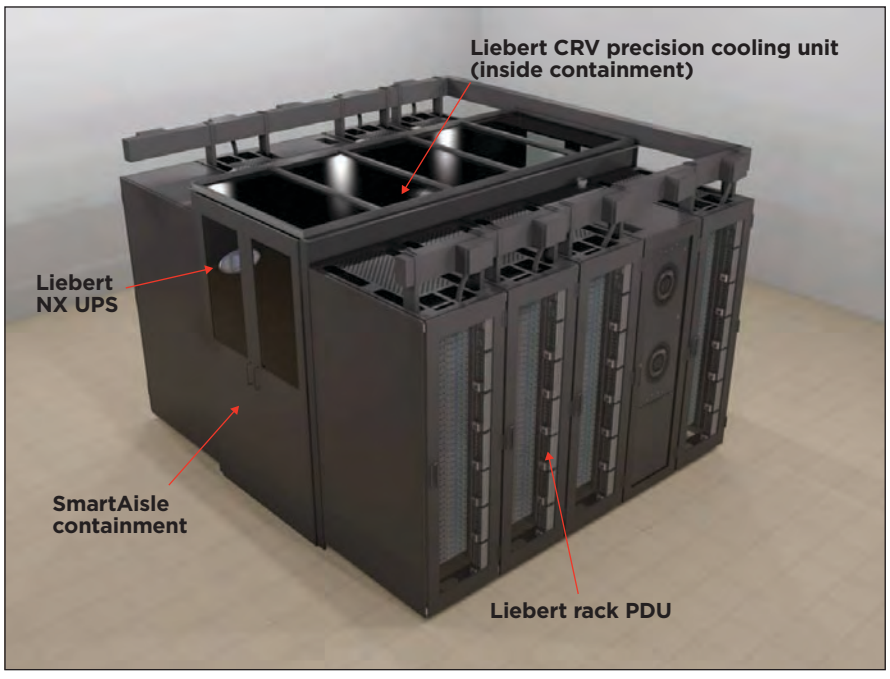


Figure 2. *SmartAisle containment helps maximize cooling unit performance and support increased rack densities*

When the cost of re-humidification is factored in, the total annual operating cost of the comfort cooling system is US$11,986 higher than the operating cost of the precision cooling system—offering payback within 12 months on the additional cost of the precision cooling system.[1]

PRECISION COOLING SYSTEMS AND STRATEGIES

Designing for high data center densities, or accelerating a migration to increased densities in an existing facility, can play a key role in helping organizations increase performance and reduce costs. Taking advantage of cooling strategies such as bringing cooling into the rack row and implementing SmartAisle containment configurations can help ensure that cooling systems can handle high-density environments.

For example, putting supplemental cooling systems close to a data center hotspot can help significantly reduce energy costs. High-density Liebert XD™ systems provide high-density cooling at the source of the heat, helping ease the load on the room cooling system. Liebert XD systems are also designed to fit a variety of space constraints—such as the top of the rack, in the row, or mounted on the ceiling—enabling high-density cooling to reach where it is needed.

Designed to be compatible with Liebert XD systems, the Liebert XDR helps accommodate growth from rack-level to row-level cooling. This rear-door module is designed to eliminate the cooling fans and utilize server fans to help efficiently transfer the server heat to the Liebert XD cooling module—helping to precisely cool specific loads with less energy waste than cooling the whole room.

The Liebert CRV offers flexibility, energy efficiency, and high value in a self-contained, row-based precision cooling unit designed for reliability. It can fit seamlessly within a row and helps protect

[1] Re-humidification based on 2.34 kW of latent removal per ton of sensible cooling for the comfort cooling system and 0.39 kW of latent removal per ton of sensible cooling for the precision cooling system, with the humidifier running from November through March for a total of 3,650 hours.

high-density equipment by precisely delivering cool air close to the heat source—the servers themselves.

Each of these systems is designed to work with the SmartAisle containment approach, which separates hot and cold airstreams to help maximize cooling unit performance and support increased rack densities using existing equipment (see Figure 2). SmartAisle containment can help reduce power consumption by up to 32 percent when used with cooling systems that have Liebert iCOM control and variable fan drives or electronically commutated (EC) fans.[2] Data centers can be retrofitted for this approach without disrupting operations, and the equipment typically occupies minimal floor space.

In addition, Liebert uninterruptible power supplies (UPSs) and power distribution units (PDUs) can help organizations economically reconfigure how power is applied within the rack and then monitored and controlled for maximum efficiency. The Liebert series of rack PDUs enables changes to receptacles, power cords, and monitoring software without discarding the existing PDU—helping to reduce costs and ensure that IT staff can accommodate ever-changing rack power requirements.

EFFICIENT DESIGNS FOR HIGH-DENSITY DATA CENTERS

As virtualization, increasingly powerful multi-core processors, and other technologies become widespread, data center rack densities will likely continue increasing as well. Containment strategies using the SmartAisle system from Emerson Network Power can address these rising heat loads and help protect sensitive equipment while controlling data center costs. In addition, row- and rack-level cooling systems target specific heat sources in the data center to help increase overall efficiency.

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Liebert solutions from Emerson Network Power:
www.liebert.com

Dell™ Energy Smart:
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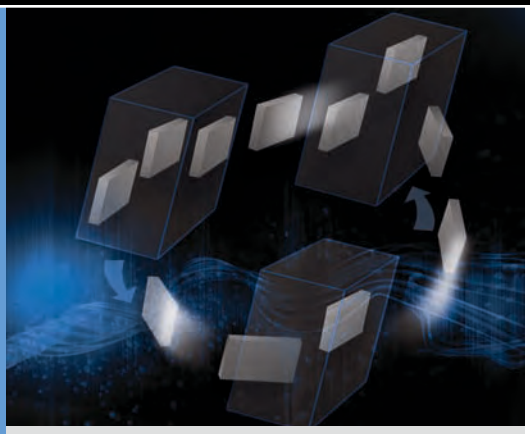
[2] Based on a data center with a 75°F average return-air temperature, 20 server racks at a load of 8 kW per rack with a delta T of 35°F, and three 56 kW air-cooled computer room air-conditioner (CRAC) units with constant-speed fans, two single-capacity compressors, a multi-fan condenser, and a delta T of 21°F, for a total system power consumption of 49.5 kW; compared with the same environment with a 92°F average return-air temperature using SmartAisle containment and three similar-sized 56 kW air-cooled CRAC units now with variable-speed fans, variable-capacity compressors, a multi-fan condenser, and a Liebert iCOM control system, for a total system power consumption of 33.9 kW.



UNIFIED VIRTUAL DATA CENTER MANAGEMENT WITH DELL EQUALLOGIC STORAGE AND CITRIX STORAGELINK

By Achmad Chadran
Chaitanya Upadhyay
Partha Ramachandran

Dell™ EqualLogic™ PS Series storage was designed around a simple truth: virtualized server environments need virtualized storage to fulfill their potential. But managing virtualized servers and storage traditionally required two consoles and two very different skill sets. Now, the Citrix Essentials™ suite and Citrix® StorageLink™ plug-in can extend single-pane management of hypervisor and storage resources across Citrix XenServer™ and Microsoft® Hyper-V™ environments.

Virtualized IT environments require shared storage to realize their full availability, scalability, and efficiency potential. However, managing virtualized server environments and storage operations using two separate management interfaces can compromise many of the efficiencies gained through virtualization. Complimentary hypervisors available for download to integrate storage management and help preserve these efficiencies have traditionally not been capable of providing enterprise-level support.

Citrix StorageLink—a key component available in the Citrix Essentials suite that provides tools designed to enhance the functionality of the complimentary versions of the Citrix XenServer and Microsoft Hyper-V hypervisors—helps overcome these shortcomings by integrating hypervisor and storage platform management operations into a single enterprise-class graphical console. With support for Dell EqualLogic PS Series Internet SCSI (iSCSI) storage area network (SAN) arrays, Citrix Essentials and the StorageLink management module further the vision for EqualLogic storage in helping simplify server virtualization through integrated storage provisioning and management for enhanced data center efficiency.

UNDERSTANDING THE CHALLENGES OF VIRTUALIZATION AND SHARED STORAGE

Although SANs can be critical to realizing the benefits of a virtualized data center infrastructure, hypervisors and SANs often do not work well together. Until recently, no single management tool existed that could adequately handle the functions of the hypervisor and the SAN. IT administrators had to toggle back and forth between two management consoles, which could become time-consuming and complex. Often, managing virtualization and storage required two separate administrators, with two different skill sets.

Dell EqualLogic PS Series iSCSI SAN arrays can address these challenges and help simplify virtualization through several key design features:

- EqualLogic SANs provide enhanced support for virtualized server infrastructures by aggregating large pools of storage resources and sharing them among virtualized servers.
- Powerful automation capabilities help to simplify IT, reduce training requirements, and enable intuitive storage management.
- Automated disk failover and advanced multipathing help ensure high availability of storage resources.

- Snapshot and cloning technologies help protect virtual machine (VM) and other data by providing space-efficient copies for backup and disaster recovery.
- EqualLogic SAN scalability helps administrators add resources online without disrupting services, and newly added arrays are included automatically in the available storage pool.
- Built-in intelligence enables EqualLogic arrays to leverage capabilities provided by third-party applications to help maximize functionality, ease of use, and performance.

These design features make the EqualLogic PS Series well suited for enterprise-class environments and help maximize data center virtualization benefits. High operating efficiency, asset protection, and management automation are at the heart of the EqualLogic design philosophy, and these attributes are well integrated with the management functionality of the Citrix XenServer and Microsoft Hyper-V virtualization platforms.

BOOSTING HYPERVISORS FOR VIRTUALIZED INFRASTRUCTURES

The Citrix Essentials suite complements and extends the efficiencies provided by Dell EqualLogic PS Series iSCSI SAN arrays through tools designed to augment the functionality of the complimentary versions of the Citrix XenServer and Microsoft Hyper-V hypervisors. IT administrators increasingly consider hypervisors a commodity—meaning that the basic hypervisor feature set should be available at no additional cost—and basic platforms are available as complimentary downloads. But although the basic, commoditized feature set includes much of the capability required for deploying virtualized infrastructures, it takes additional features to make the infrastructures enterprise worthy. Citrix Essentials is designed to add functionality and usability to the complimentary versions of the XenServer and Hyper-V hypervisor platforms, and IT managers can use them to successfully deploy enterprise virtualization infrastructures.

By seamlessly integrating storage with hypervisor-layer functions, Citrix Essentials provides a set of virtualization management and automation capabilities that help IT managers transform data centers into proactive and automated delivery centers. For example, administrators can create VMs and associated virtual storage together, quickly reallocate the server and storage resources to help meet changing workload requirements, and monitor how the storage is being used by the VMs. In addition, workflow orchestration in the Citrix Workflow Studio™ tool allows administrators to write scripts to automate workflows and easily manage tasks.

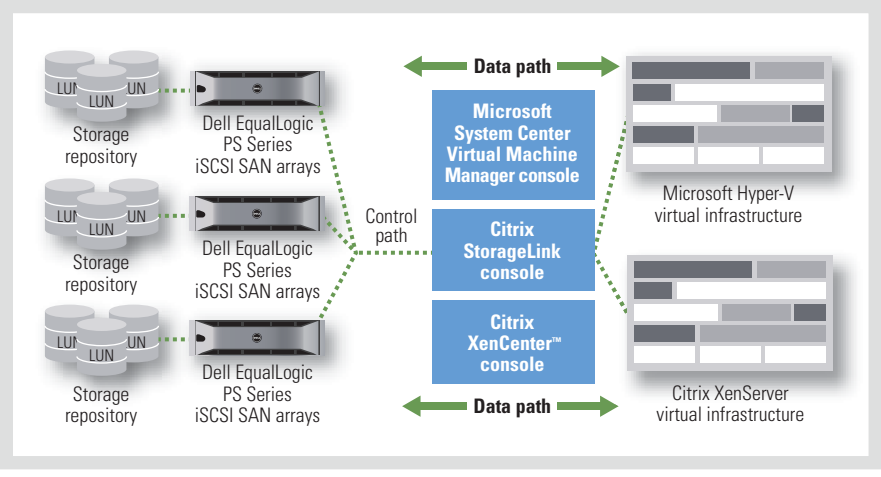


Figure 1. *Virtualized infrastructure management in a single Citrix StorageLink console*

Citrix Essentials also facilitates additional capabilities beyond the hypervisor layer, including the following:

- **Automated lab management:** Helps reduce management complexity and costs by enabling the creation of an isolated software environment where developers can fix problems, test new products, or provide training
- **Live workload migration:** Supports live migration between Hyper-V hosts or between XenServer hosts through shared storage provisioned by Citrix StorageLink
- **Stage management:** Streamlines the process of building, testing, sharing, and delivering applications into production environments by allowing developers to stage software releases or test software patches before deployment
- **Dynamic provisioning:** Provides simplified workload deployment to combinations of virtualized or physical servers from a single golden image, helping to streamline IT administration and promote image consistency

By delivering these capabilities in one convenient set, the Citrix Essentials suite helps to reduce complexity and total cost of ownership of IT infrastructure. Organizations can minimize the need for proprietary, segmented storage functionalities that require duplication of effort and can consume valuable computing resources in the host environment.

USING A SINGLE CONSOLE TO MANAGE VIRTUALIZED PLATFORMS

A single intuitive graphical interface can be used to manage both the hypervisor and the storage operations that are routinely part of virtualization, including creating, copying, and cloning VMs. The Citrix StorageLink management module thus combines the benefits of Dell EqualLogic PS Series iSCSI SANs and the Citrix Essentials suite. StorageLink is designed

STEP BY STEP: SIMPLIFYING VIRTUAL MACHINE DEPLOYMENT WITH CITRIX STORAGELINK

Deploying large numbers of virtual machines (VMs) is possible without Citrix StorageLink, but it can be a time-consuming and error-prone task when attempted manually. StorageLink helps simplify the process at each step:

1. **Deploying multiple new VMs:** Without StorageLink, an IT manager must create all the logical units (LUNs), mount and format them, create all the VMs, and then match and attach each. StorageLink helps automate these processes because it can communicate with both the Citrix XenServer and Microsoft Windows Server® 2008 Hyper-V hypervisors and the storage area network (SAN).
2. **Attaching VMs to LUNs:** The usual practice of attaching many VMs to one LUN creates a heavy I/O load. StorageLink helps IT managers create separate LUNs for each virtual disk of each VM while reducing the management overhead associated with this approach.
3. **Coordinating between servers and storage:** Application programming interfaces (APIs) "translate" between the hypervisor and SAN without requiring the involvement of storage administrators. This automation helps free IT managers to work on tasks with strategic business value.

By simplifying underlying processes and abstracting them into logical business and management operations, StorageLink helps advance the full realization of the virtualization vision.

to simplify VM provisioning and extend single-pane management of storage and hypervisor segments across Citrix XenServer and Microsoft Hyper-V environments (see Figure 1).

IT administrators can create a standard configuration for a VM and then replicate that configuration with just one or two mouse clicks through an automatically *sequentialized* set of tasks—some on the hypervisor side and some on the storage side—to help reduce the number of steps required to perform routine operations. The StorageLink management capability helps reduce the need for separate teams of server administrators, who manage the provisioning of VMs across physical servers, and storage administrators, who manage storage environments for seamless deployment of VMs.

Administrators can leverage the application programming interfaces (APIs) of both hypervisor and storage platforms to help provide seamless integration throughout the virtualization process, from auto-discovery through provisioning and maintenance operations. StorageLink is designed to add a layer of automation for integrated hypervisor and storage functionality, including new VM provisioning (see the "Step by step: Simplifying virtual machine deployment with Citrix StorageLink" sidebar in this article), "fast clone" provisioning of multiple standard images, and cluster-related storage configuration with support for high-availability environments. Planned enhancements intend eventually to enable administrators to move VMs back and forth between XenServer virtual environments and Hyper-V virtual environments.

EXTENDING HYPERVISOR AND STORAGE MANAGEMENT

Shared storage can be tricky to implement in virtualized environments. Hypervisors and SANs often require separate management platforms, and no single tool has been available for adequately managing the functions of the hypervisor and the SAN.

Dell EqualLogic PS Series iSCSI SANs provide virtualized storage designed to help organizations fulfill the goal of simplifying their IT infrastructures. The Citrix Essentials suite helps complement and extend the efficiencies and automation provided by EqualLogic storage by offering tools designed to enhance the functionality of the complimentary Citrix XenServer and Microsoft Hyper-V hypervisors.

Citrix StorageLink enhances these efficiencies by automating routine tasks and providing single-pane management of both hypervisor and storage operations. As a result, IT managers can easily manage host-side operations such as VM startup and shutdown as well as SAN-based capabilities such as VM creation using EqualLogic PS Series snapshots. StorageLink also helps extend the benefits of single-pane management across both XenServer and Hyper-V platforms, helping to avoid the complexity of dual management interfaces—and moving virtualized IT environments significantly closer to realizing their full Efficient Enterprise potential.

Achmad Chadran is a storage solution marketing manager in the Dell EqualLogic organization.

Chaitanya Upadhyay works for the Citrix StorageLink Product Management team, focusing on partner integration and relationship management.

Partha Ramachandran is a principal software engineer at Citrix.

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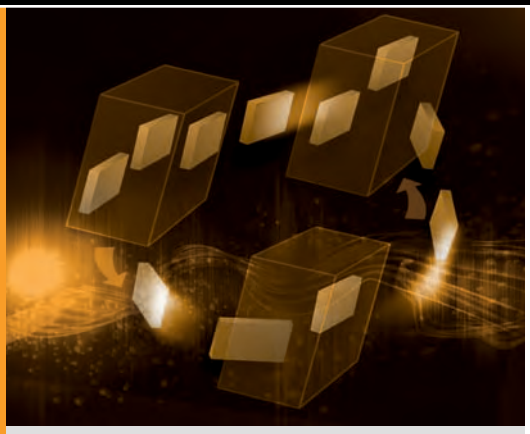

VIRTUALIZING MICROSOFT APPLICATIONS WITH VMWARE vSPHERE ON DELL SERVERS AND DELL EQUALLOGIC STORAGE

By Andrew Gilman

Deploying VMware® vSphere™ 4 virtualization with 11th-generation Dell™ PowerEdge™ servers and Dell EqualLogic™ PS Series Internet SCSI (iSCSI) storage helps IT organizations confidently virtualize mission-critical Microsoft® applications and achieve outstanding performance, simplified management, and granular data protection.

Organizations in a wide range of fields are virtualizing their data centers in an effort to reduce costs, enhance resource utilization, increase IT responsiveness, and maximize the flexibility of both IT and the enterprise. After beginning with file share, print, Web, and legacy applications, many IT groups are now looking to virtualize mission-critical applications such as Microsoft Exchange, Microsoft SQL Server®, and Microsoft Office SharePoint® Server software. To succeed with this next phase of virtualization, administrators must ensure that their infrastructure is up to the task.

Because applications share resources in a highly consolidated IT environment, administrators need tightly integrated, virtualization-optimized software, servers, and storage that can work together to deliver the scalable performance that helps ensure fulfillment of service-level agreements (SLAs). They also require granular data protection and data recovery capabilities that can prevent the loss of critical data, enhance recovery time, and support enterprise productivity and responsiveness. And they must be sure that virtualizing these applications can extend the value of their virtualized infrastructure without adding costs or complexity.

Dell has worked closely with Microsoft, VMware, and Intel to develop products and tools that help organizations confidently virtualize and protect key Microsoft applications (see the "Dell Infrastructure Consulting helps accelerate virtualization deployments" sidebar in this article). Combining VMware vSphere 4 with 11th-generation Dell PowerEdge servers and Dell EqualLogic PS Series Internet SCSI (iSCSI) storage area network (SAN) arrays can help IT groups extend the benefits of virtualization to Microsoft applications while simplifying IT management and enhancing data protection.

VMWARE vSPHERE 4: EXTENDING THE SOFTWARE FOUNDATION FOR VIRTUALIZATION

The VMware vSphere 4 virtualization platform can play an important role in extending virtualization to mission-critical Microsoft applications. Designed as a cloud computing OS, vSphere enables IT groups to apply a flexible and highly scalable cloud model within their internal IT infrastructure.

Adopting vSphere for Microsoft Exchange, SQL Server, or SharePoint enables organizations to consolidate their hardware and run these applications cost-effectively with managed SLAs. For example, organizations can potentially move two Exchange hubs, each running five physical servers, onto just two physical servers running vSphere. In the process, they can consolidate Exchange server roles and help avoid the need for dedicated standby servers. Similarly, they could potentially migrate four instances of SQL Server,

each running on its own physical server, to just one host running vSphere—helping substantially reduce hardware and software licensing costs (see Figure 1).

vSphere also helps organizations achieve high performance for Microsoft applications when moving those applications to a virtualized environment. In vSphere 4 deployments, administrators can dramatically increase the server resources allotted to each virtual machine (VM) while decreasing the resource overhead incurred by running VMware software. This current release is designed to support VMs configured with up to 8 virtual processors, 256 GB of RAM, and 40 Gbps of I/O. Meanwhile, the server overhead for running vSphere continues to decrease steadily with each successive release. Capitalizing on these capabilities with high-performance 11th-generation Dell PowerEdge servers can enable organizations running SQL Server on vSphere 4 to easily scale their deployments as enterprise needs grow.

VMware Distributed Resource Scheduler (DRS) helps sustain that high application performance without requiring manual intervention from administrators. This automated, policy-based capability is designed to monitor resources used by VMs and applications and perform load balancing across physical hosts to avoid resource constraints. If an application approaches the resource limits of the physical host, VMware DRS can move the application to another host to help avoid performance degradation for end users.

vSphere also offers high-availability capabilities that help ensure business continuity in the event of physical hardware problems or a disaster that affects the entire data center. VMware High Availability (HA) constantly monitors VMs, and if an OS or hardware failure occurs, it can automatically restart VMs on another physical server without manual intervention. VMware Fault Tolerance (FT) enables administrators to create—with just a single click in the interface—a mirrored Exchange or SQL Server VM that runs in lockstep with the original. If there is a problem with the primary instance, the application can fail over transparently to the mirrored version, helping avoid downtime or data loss for end users.

DELL INFRASTRUCTURE CONSULTING HELPS ACCELERATE VIRTUALIZATION DEPLOYMENTS

Dell Infrastructure Consulting applies the experience accumulated through thousands of engagements to help organizations take full advantage of data center virtualization. Dell team members can provide an assessment to help evaluate potential IT benefits and make a business case for virtualization. By offering an array of tools and guidance on best practices, they can also assist with virtualization design, planning, and implementation to help accelerate the deployment process, reduce complexity, and avoid risks inherent in migrating mission-critical applications to a virtualized environment.

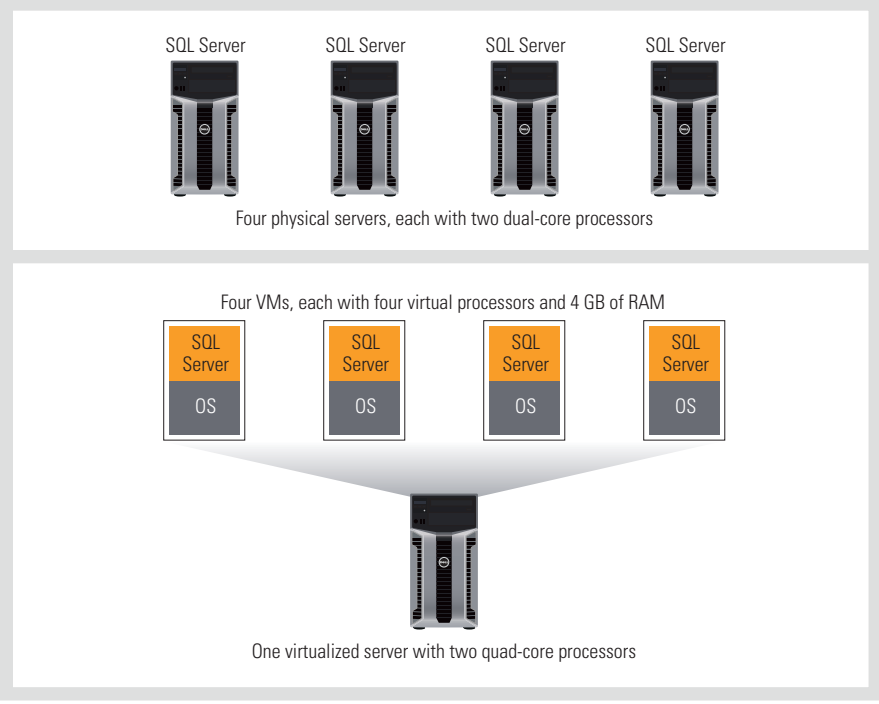

Figure 1. *Migrating four instances of Microsoft SQL Server to a single host running VMware vSphere*

DELL POWEREDGE SERVERS: DELIVERING PERFORMANCE FOR MISSION-CRITICAL WORKLOADS

11th-generation Dell PowerEdge servers provide a robust hardware foundation for running Microsoft applications in an environment virtualized with VMware vSphere 4. Equipped with the Intel® Xeon® processor 5500 series, these PowerEdge servers are designed to deliver outstanding processing performance, significantly greater memory bandwidth, and enhanced energy efficiency compared with previous-generation servers. Consequently, 11th-generation PowerEdge servers running vSphere 4 can deliver up to 160 percent greater performance[1] and up to 130 percent more energy efficiency than servers based on previous-generation platforms. The increased performance, power efficiency, memory capacity, and networking ability of this latest generation of PowerEdge servers can help organizations

[1] Based on VMmark benchmark testing performed by Dell Labs in March 2009 on a Dell PowerEdge R710 server running VMware ESX 4.0 (results published April 21, 2009), compared with September 2008 tests on a Dell PowerEdge 2950 III server running VMware ESX 3.5.0 Update 2 (results published September 29, 2008). For details and complete results, visit www.vmware.com/products/vmmark/results.html.

achieve greater consolidation ratios for hosted VMs than previous-generation servers, helping reduce costs by further consolidating hardware.

Combined engineering efforts by Dell, VMware, and Intel have created a range of capabilities that help simplify the deployment and management of virtualized environments. With an optional embedded VMware hypervisor, 11th-generation PowerEdge servers help avoid the need to download or install additional software to get started. Meanwhile, Intel Virtualization Technology (VT) FlexMigration allows administrators to integrate multiple generations of Intel Xeon processor–based servers into the server environment, facilitating deployment and helping protect existing investments. To help ensure the compatibility of hardware and software components, Dell and VMware have tested and validated tier-1, mission-critical application workloads in environments that combine vSphere 4 with PowerEdge servers and Dell EqualLogic PS Series iSCSI SAN arrays.

VMware functions are tightly integrated into PowerEdge management tools. The Dell OpenManage™ management suite for VMware ESXi enables administrators to manage, monitor, and update PowerEdge servers running VMware ESXi with a selection of management tools, including the Dell Management Console Powered by Altiris™ from Symantec™ (see the "Dell Business Ready Configurations help simplify virtualization" sidebar in this article).

To help deliver high application availability and avoid unplanned outages, Dell servers include multiple redundant components. For example, the PowerEdge M1000e modular blade enclosure can be equipped with redundant power supplies, redundant cooling fans, and up to six total I/O modules for three redundant fabrics. IT groups can also select a redundant Chassis Management Controller (CMC) to help ensure uninterrupted access to key management functions.

DELL EQUALLOGIC SANs: STORING AND PROTECTING MISSION-CRITICAL DATA

Dell EqualLogic PS Series iSCSI SAN arrays provide an excellent complement to a VMware vSphere 4 environment running Microsoft applications on Dell PowerEdge servers. As with the virtualized server environment, EqualLogic arrays help administrators consolidate storage and increase flexibility. EqualLogic arrays also include a variety of capabilities to help ensure application availability and deliver granular protection for critical data while providing high levels of performance. In Dell-commissioned tests performed by Principled Technologies in November 2008, for example, a Dell EqualLogic PS Series iSCSI SAN under a Microsoft Exchange Server Jetstress workload delivered 86 percent more achieved IOPS per disk than an HP StorageWorks 4400 4 Gbps Fibre Channel array.[2]

Designed to provide virtualized storage, EqualLogic arrays use a peer storage architecture that enables them to share resources, evenly distribute workloads, and provide data protection for VMs. Data volumes are provisioned automatically from a single scalable pool of storage. EqualLogic SANs apply resources automatically even as virtualized servers and their workloads change. Nondisruptive, online migration of data volumes among storage tiers and pools allows administrators to reallocate physical storage resources to help meet changing needs or to accommodate specific workloads.

This virtualized storage environment provides the flexibility to accommodate a dynamic IT infrastructure. EqualLogic arrays enable administrators to mix and match arrays with different disk types within the same SAN, using solid-state drives (SSDs), Serial Attached SCSI (SAS) drives, or Serial ATA (SATA) drives depending on the needs of their organization. And adding capacity is simple: with the modular design of the EqualLogic PS Series, administrators can add arrays without disrupting operations. The arrays can automatically balance loads across resources to help ensure consistent application performance.

The EqualLogic PS Series is also designed to deliver the high availability required for mission-critical applications. Redundant, hot-swappable components—including power supplies, controllers, enclosures, and disk drives—can help prevent unplanned outages. With the modular architecture, redundancy increases dramatically as resources are added. Administrators can also set up redundant Dell PowerEdge servers and Dell PowerConnect™ switches to

DELL BUSINESS READY CONFIGURATIONS HELP SIMPLIFY VIRTUALIZATION

Dell now offers Business Ready Configurations for virtualization based on VMware vSphere 4 to help avoid cost-inefficient, time-consuming trial-and-error processes during infrastructure design and implementation. The engineer-tested configurations, which integrate VMware software with Dell PowerEdge servers and Dell EqualLogic PS Series storage, enable IT organizations and business groups to confidently migrate mission-critical Microsoft applications to a virtualized environment.

These prebuilt configurations offer simplified design, ordering, and deployment of production-ready virtualization infrastructures and include best-practice recommendations and guidelines. They can be deployed as designed or customized to meet individual requirements. By using Dell Business Ready Configurations, IT staff can refocus their time and energy on other strategic tasks.

[2] For the complete report, including detailed information on the test environment, benchmark workloads, methodology, and results, see "Exchange 2007 SAN Performance Test: Comparing Performance Between Dell EqualLogic PS Series SAN and HP StorageWorks 4400 Enterprise Virtual Array," by Principled Technologies, November 2008, www.principledtechnologies.com/clients/reports/dell/EQLPS5000XVExchange1108.pdf.

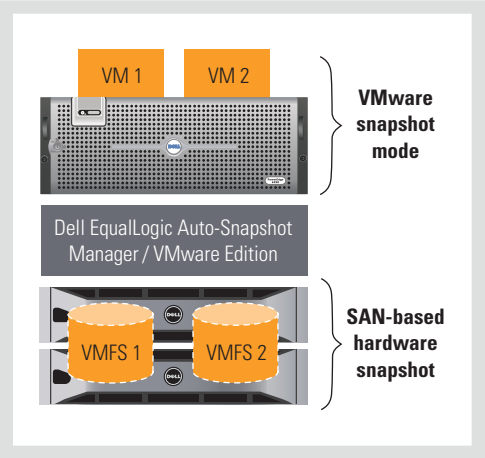

Figure 2. *Protecting virtual machine and application data on Dell EqualLogic PS Series storage*

help remove single points of failure from the storage network.

To strengthen availability and scalability, the EqualLogic Multipathing Extension Module (MEM) for vSphere 4—available in a beta version at press time—is expected to provide storage-aware, end-to-end management of the data path between the host and storage and help automate the process of creating and managing multipath connections to deliver high levels of performance and reliability. If there is a problem with an array or a need for additional capacity, the MEM is designed to load balance the SAN and help ensure that applications continue to run smoothly. For example, during high traffic times for Microsoft Exchange, the MEM could help ensure that all paths are utilized efficiently, so end users can access their e-mail without experiencing performance issues.

EqualLogic arrays can also help avoid downtime during management tasks and capacity upgrades. Administrators can use vSphere and EqualLogic arrays to provision VMs and reconfigure applications while they remain online. Similarly, administrators can add storage capacity or reallocate storage without taking the system offline.

By integrating EqualLogic PS Series SANs into the vSphere environment, IT organizations can implement multilayered data protection for mission-critical applications. EqualLogic Auto-Snapshot Manager / VMware Edition 2.0 uses VMware vStorage application programming interfaces (APIs) to create fast, online, hypervisor-aware snapshots, clones, and remote replicas of VMs and VMware Virtual Machine File System (VMFS) data stores. An easy-to-use interface enables administrators to create automated schedules for individual VMs, groups, or even all VMs in the data center, helping save time compared with the manual creation of VM snapshots. By producing space-efficient, SAN-based snapshots, Auto-Snapshot Manager / VMware Edition enables organizations to back up data frequently, without using excessive storage capacity (see Figure 2). Administrators can also replicate data to off-site locations for additional protection.

Auto-Snapshot Manager / Microsoft Edition helps protect application data by taking application-aware snapshots for virtualized transactional workloads from Exchange, SQL Server, and other Microsoft applications as well as Microsoft file systems. It includes built-in scheduling capabilities so administrators can create frequent, automated backups, as well as replication capabilities for storing application-aware snapshots off-site to help protect against disasters. Integration with Microsoft Cluster Service (MSCS) and Volume Shadow Copy Service (VSS) helps produce clean, consistent snapshots that can be restored successfully.

The VMware vCenter™ Site Recovery Manager (SRM) Storage Adapter for EqualLogic arrays helps organizations capitalize on the tight integration of the EqualLogic PS Series and VMware vCenter Server to provide automated disaster recovery. Administrators can easily and cost-effectively configure replication between EqualLogic arrays using the included auto-replication feature, and can configure VM protection groups and recovery plans using SRM. They can also test recovery plans without affecting production environments. At the time of failover, SRM can automatically run the recovery plan, booting up VMs in a predetermined order.

VIRTUALIZING MISSION-CRITICAL MICROSOFT APPLICATIONS

By combining VMware vSphere 4 with 11th-generation Dell PowerEdge servers and Dell EqualLogic PS Series iSCSI SANs, organizations can gain the confidence they need to virtualize mission-critical Microsoft applications. vSphere 4 virtualization allows organizations to take advantage of the performance capabilities of 11th-generation PowerEdge servers and continue to deliver outstanding performance for these applications after they have been migrated to the virtualized environment. Tight integration among vSphere, PowerEdge servers, and EqualLogic PS Series storage helps to simplify management of a unified environment that can deliver powerful and granular protection for VM and application data. Together, Dell and VMware are helping IT organizations realize the full potential of data center virtualization and enabling them to enhance support of business goals.

Andrew Gilman is a storage solutions marketing manager at Dell responsible for virtualization marketing activities. Andrew has a degree in Business Administration from the Boston University School of Management.

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www.vmware.com/products/vsphere

Dell PowerEdge servers:
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Dell EqualLogic PS Series:
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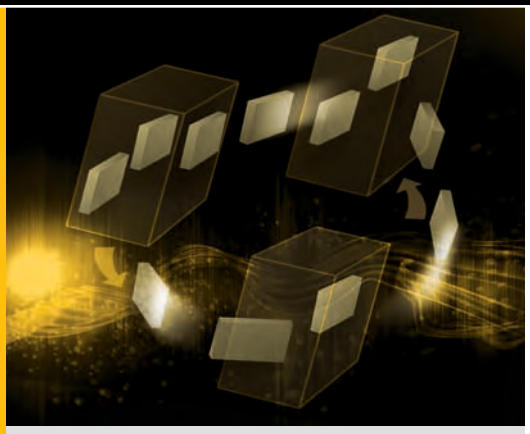

CONSIDERATIONS FOR THE CONSOLIDATION AND VIRTUALIZATION OF MICROSOFT SQL SERVER

By Anthony Fernandez
Kevin Guinn

Through the twin strategies of database consolidation and server virtualization on Dell™ servers and storage, IT organizations can develop a Microsoft® SQL Server® infrastructure designed for flexibility, high availability, ease of management, security, and access control while helping to reduce overall cost and complexity.

IT organizations face an enormous challenge to keep operations up and running 24/7 while contending with increasing demands and growing complexity, even to the point where it becomes difficult for employees to request resources to perform their tasks. As a result, these organizations may resort to circumventing IT standards and procedures to help accelerate their processes, which in turn can lead to server sprawl—especially at the database tier.

Databases store and provide data for typical application environments, which are generally designed around a Web tier, an application tier, and a database tier, and may also include a storage tier. With the advent of standardized hardware, this type of architecture allows the compartmentalization of applications and separation of resources, with hardware at each tier supporting a specific function and requiring a specific set of management tools. This same separation of resources, however, can also enable employees to easily deploy database servers for testing and development without the IT department's oversight and management.

The apparent benefits of simplified deployment and development can easily be overshadowed by potential challenges such as incompatibility issues during deployment to production (thus delaying time to market) and security vulnerabilities in un-patched systems. Over time, however, servers that were deployed for a specific project that is no longer active are often maintained in case a need arises to continue testing and quality assurance processes. In the meantime, processor cycles are lost to idle systems that consume valuable power, adding to bottom-line costs.

It quickly becomes apparent that unmanaged server sprawl can become highly complex, adding to the data center footprint and the costs for management, security, and power and cooling. For Microsoft SQL Server deployments, IT administrators can help counter this sprawl by taking advantage of database consolidation and virtualization on Dell servers and storage as part of an overall IT strategy for efficient operations.

OVERALL IT STRATEGY DEVELOPMENT

The first step to developing a successful overall IT strategy that can overcome sprawl is to identify current challenges. As IT departments add hardware to cope with increasing user and application demands, the data center footprint typically also increases. This additional hardware, in turn, often leads to increased power and cooling costs as well as management complexity.

Developing a comprehensive inventory of all hardware and application software, along with all dependencies, is essential to developing enterprise goals based on areas in need of improvement. For example, an inventory may reveal that a large

number of hardware resources are not efficiently utilized or that the environment includes too many unmanaged servers that may lead to security risks. This information can help shape goals such as increasing server utilization, reducing security risks, and lowering power and cooling costs in the data center. Meeting these goals, in turn, can help simplify and streamline IT operations.

Figure 1 shows a high-level view of the process for developing a strategy that can help IT organizations meet their goals. After the challenges and goals have been identified, developing a successful strategy requires an in-depth analysis of the current environment, focusing on the challenging areas. This analysis should reveal the key aspects of how hardware and software are being used and the internal and external dependencies. Understanding exactly how the systems are being used, which applications and users are utilizing them and when they are doing so, and the expected service-level agreements (SLAs) of those applications and users helps determine whether a specific system is a candidate for consolidation or virtualization. This information also helps in sizing the target configuration on which to consolidate databases or virtualize servers.

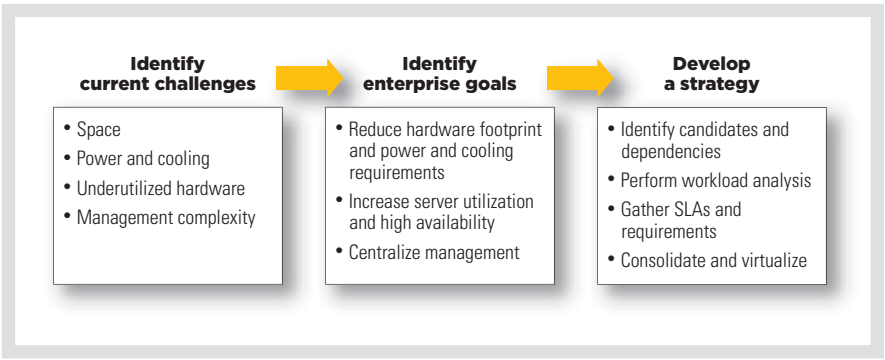

Figure 1. *High-level process for developing an overall IT strategy to help overcome server sprawl*

DATABASE CONSOLIDATION AND VIRTUALIZATION

Based on the analysis of the candidate systems, the choice between consolidating Microsoft SQL Server databases onto a single physical server or creating virtual machines (VMs) that host independent database containers can vary depending on the goals of the organization, the number of databases, the SLAs, the results of the workload analysis, and other factors (see Figure 2).

Database consolidation

A *scale-up* consolidation strategy aims to consolidate SQL Server instances onto a reduced number of physical servers. It

	Consolidation	Virtualization
Disaster recovery	Must be implemented at each level (hardware, software, instances, and databases); typically requires full hardware redundancy and an additional server for failover; should include scheduled backups to disk and tape for short- and long-term archiving and retrieval	Must be implemented at each level (hardware, software, VMs, instances, and databases); also can take advantage of scheduled VM snapshots to help quickly restore OS and database states
Planned downtime	Enables patching and upgrades through a restart failover to a passive cluster node	Enables entire VMs to move seamlessly between hosts during hardware maintenance and upgrades
Testing and development	Can mean that server reboots as a result of testing and development will affect other databases and users on the same system; if server parameters need modification it could introduce hardware sharing challenges; requires administrators to cater performance tuning to all hosted databases	Offers comprehensive control over OS parameters to test database impact, perform reboots, and so on without requiring downtime for other users on same host
Dynamic deployment	Can lead to a rigid environment; requires hardware setup, software installation, and migration or creation of databases where even slight variations in hardware configuration can force administrators to create multiple images; requires strict account management for all logins, such as database users and system users	Allows quick VM deployment through templates and cloning; enables administrators to quickly provision a VM when users require a new system for development, testing, training, and so on
Licensing costs	Helps reduce OS and application licensing costs by consolidating onto a reduced number of servers	May add licensing costs for hypervisors as well as each VM OS and application, depending on version edition, number of VMs, and licensing schema*
Recommendations	Can be well suited for production environments where hardware and operating systems are protected from application users and database administrators	Can be well suited for dynamic environments that require comprehensive control over databases and operating systems, quick deployment, and deallocation of virtual systems

* For more information, visit www.microsoft.com/licensing/about-licensing/virtualization.aspx.

Figure 2. *Key considerations for consolidation and virtualization strategies*

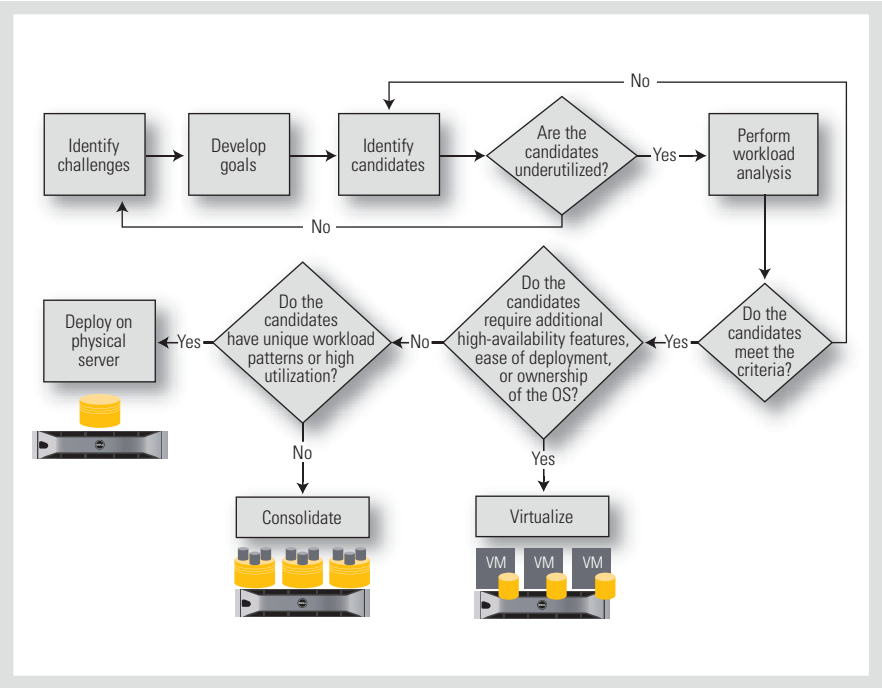

Figure 3. *Recommended process for identifying candidate databases for consolidation and virtualization*

typically involves adding as many processors and as much memory as possible to a physical system and then consolidating multiple databases or instances on that system—for example, a single Dell PowerEdge™ R900 server with four six-core processors and 256 GB of RAM can host a large number of instances and databases. The advantage of this strategy is that it can help to reduce licensing costs and simplify management. The challenge is to provide high availability for planned and unplanned downtime for a large set of databases. Clustering and mirroring can provide ways to mitigate this problem; however, implementing a high-availability solution can prove difficult for administrators, because all the databases on a system must fail over when that system experiences downtime.

A *scale-out* consolidation strategy uses smaller systems than the scale-up strategy, with enough processing power and memory to support workloads with a small number of databases. The advantage of this strategy is that it helps avoid the single points of failure that can occur when one system holds all the databases in the environment. With cost-effective, standards-based hardware, this strategy is widely implemented to mitigate large monolithic systems that hold data for the entire enterprise. The challenge here is that the large number of servers can lead to server sprawl and increases in complexity, maintenance overhead, and power and cooling requirements. Over time, the costs associated with this model can potentially outweigh its advantages.

Server virtualization

In the past, if a new system was needed, IT staff had to purchase or repurpose hardware, account for power and cooling requirements, and deploy the server with a fresh OS image—a process that could potentially take days, weeks, or even months. By allowing a single physical server to support multiple VMs, virtualization can dramatically reduce the time for this allocation process. Virtualization can also help organizations to maximize hardware resource utilization, maintain a logical separation of applications running on the same hardware, increase system availability, and reduce management and downtime associated with information silos.

As VMs proliferate in enterprise environments, the complexity of the underlying storage does as well—potentially eliminating gains achieved through increased server hardware utilization and power and cooling reductions. Dell EqualLogic™ Internet SCSI (iSCSI) storage area network (SAN) virtualization technology helps to simplify the overall environment and enable organizations to realize similar gains at the storage layer. EqualLogic storage also offers multiple other advantages, including seamless rebalancing as array members are added, the ability to leverage familiar Ethernet components for storage traffic rather than specialized hardware, simplified management and high-availability features included at no additional cost, and comprehensive integration with the Microsoft Volume Shadow Copy Service (VSS) framework for snapshots and clones.

BEST PRACTICES AND RECOMMENDATIONS

Figure 3 summarizes the recommended process for determining whether a particular database workload is a good candidate for consolidation or virtualization. First, organizations should identify candidate database systems based on the challenges and enterprise goals, and then verify the characteristics of these workloads. Analysis of the results can help determine whether each system meets the criteria specified by the enterprise goals. The candidates can then be either consolidated or virtualized depending on the desired feature set and SLAs. If these needs dictate a contained environment or require complete control over the application and OS, then virtualization may offer the best solution. However, if the candidate database is currently underutilized, but is subject to strict SLAs or expected to grow rapidly, then migration to a consolidated environment or a dedicated physical system may be preferable.

To help simplify the design and deployment of virtualized infrastructures, Dell offers solution architecture bundles for Dell PowerEdge servers, Dell EqualLogic storage, and virtualization. These bundles are based on configurations and best practices designed to achieve comprehensive redundancy—helping to avoid single points of failure, increase scalability, and simplify management.

In addition, because many database servers need external storage for high-throughput workloads, Fibre Channel SANs require careful planning and design to achieve data separation when creating logical units (LUNs)—which can quickly add management overhead as additional databases are deployed. Virtualized Dell EqualLogic iSCSI SANs can help to simplify LUN creation and management and increase administrator productivity.[1]

EFFICIENT DATABASE DEPLOYMENTS

IT organizations must consider a range of factors when developing a strategy to help maximize hardware utilization and reduce costs associated with server sprawl. The strategies, best practices, and recommendations outlined in this article can serve as a starting point for organizations that wish to consolidate or virtualize Microsoft SQL Server databases onto efficient, high-performance Dell servers and storage to help simplify and optimize their database infrastructure.

Anthony Fernandez is a senior engineer with the Dell Global Solutions Engineering organization, focusing on database optimization and performance. Anthony has a bachelor's degree in Computer Science from Florida International University.

Kevin Guinn is a lead engineer in the Dell Global Solutions Engineering organization. His work is focused on Microsoft SQL Server and SharePoint® solutions and technologies. Kevin has a B.S. in Mechanical Engineering from the University of Texas at Austin and over 15 years of experience in IT.

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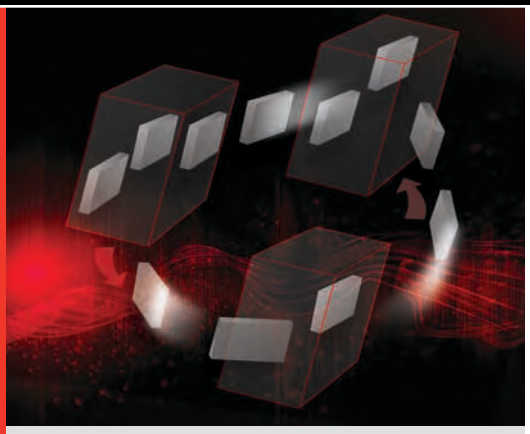
[1] For a thorough analysis of the consolidation and virtualization of SQL Server databases on Dell servers and storage, including reference architectures and detailed laboratory test results demonstrating the significant benefits possible with these strategies, see "Considerations to Consolidate and Virtualize Microsoft SQL Server on Dell PowerEdge Servers and Dell EqualLogic Storage," by Anthony Fernandez, Dell Product Group, July 2009, available in the "Dell Deployment Guidance White Papers" section at DELL.COM/SQL.



ORACLE VM: EASE OF DEPLOYMENT AND MANAGEMENT FOR VIRTUALIZATION

By Rodrigo Gonzalez
Jaime Delgado

Virtualization is key to an effective and flexible infrastructure—but for many organizations, creating a virtualized environment may seem complex. With Oracle® VM and Dell™ servers and storage, organizations can use an open source solution to help smooth the transition to virtualization, reduce costs, increase efficiency, and accelerate application deployment.

In a time when budgets are tight and enterprise demands on technology are growing, virtualization offers a way to help IT administrators expand capabilities, increase resource utilization, and reduce total cost of ownership—all of which can be critical in the ongoing struggle to maximize efficiency. The question, then, is how best to make the move to a virtualized environment. Making the transition smoothly, cost-effectively, and with minimal risk is key. So too is being able to efficiently and effectively manage that environment once it is in place. For many organizations, the path forward may not be clear.

Oracle VM offers scalable, cost-effective server virtualization that supports both Oracle and non-Oracle applications. Designed for ease of installation and use, Oracle VM on Dell servers and storage can help increase efficiency, enable rapid application deployment in a virtualized environment—and ultimately help IT organizations and the enterprise as a whole see an increase in cost-effectiveness and flexibility along with a solid return on investment.

INCREASING EFFICIENCY IN VIRTUALIZED ENVIRONMENTS

Oracle VM consists of open source server virtualization software and the integrated, Web browser–based Oracle VM Manager console. The easy-to-use graphical interface offers a simplified way to create and manage virtual machine (VM) pools running on x86- and x86-64-based systems—including creating, cloning, sharing, configuring, booting, and migrating VMs hosted on Dell systems across the enterprise. It supports both Microsoft® Windows® and Linux® operating systems, offering the flexibility to move from a mix of proprietary systems to a single standard OS.

A key advantage of Oracle VM is the increased efficiency it can bring to enterprise IT environments. For example, benchmark tests conducted by the Tolly Group found that Oracle VM performance compared favorably with the performance of a non-virtualized physical server, requiring minimal virtualization overhead while also scaling effectively when adding a second VM (see the "Benchmarking Oracle VM performance" sidebar in this article).

At the same time, Oracle VM is designed to operate in an era of tight budgets. In addition to supporting cost-effective, industry-standard Dell PowerEdge™ servers, Oracle VM itself is available as a complimentary download, with no licensing costs or complexity. Oracle Technical Support services may also be acquired from Oracle as part of cost-effective programs that can help ensure the successful implementation and use of Oracle VM. This support can offer enterprise IT administrators a single point of support for their entire software stack, from the

virtual layer to the OS, Oracle Database, Oracle Fusion Middleware, and Oracle Applications software.

CONTROLLING THE VIRTUALIZATION LIFE CYCLE

Oracle VM is designed to provide control over the entire virtualization life cycle, including VM creation, customization, sharing, management, and deployment, to help increase flexibility, manageability, and efficiency. In fact, Dell itself has deployed Oracle VM to abstract its Oracle software deployments from the underlying hardware and simplify life cycle management (see the "Maximizing Dell IT efficiency with Oracle VM" sidebar in this article).

Oracle VM includes two basic components (see Figure 1):

- **Oracle VM Server:** A self-contained virtualization environment designed to provide a lightweight, secure, server-based platform for running VMs
- **Oracle VM Manager:** An integrated, Web browser–based management console for Oracle VM Server

Administrators can also deploy the Oracle VM Management Pack, which plugs into Oracle Enterprise Manager Grid Control to create a comprehensive solution for managing VMs as well as the operating systems and software running inside the VMs. This management pack provides integrated, in-depth health and performance monitoring, configuration management, and life cycle automation for both physical and virtualized infrastructures to help support maximum operational efficiency.

Minimizing or eliminating planned and unplanned downtime is a key element in virtualized environments. Oracle VM incorporates several high-availability features, and can automatically restart failed VMs on other servers in the server pool after an unexpected host or VM outage.

BENCHMARKING ORACLE VM PERFORMANCE

In July 2008, the Tolly Group—an independent, third-party test lab—performed Oracle-commissioned tests comparing the performance of a virtualized server running Oracle VM virtual machines (VMs) against the performance of a non-virtualized physical server. The tests used a custom server configured with one dual-core Intel® Xeon® 5060 processor at 3.2 GHz and 4 GB of RAM (for the physical-server and single-VM tests) or two processors and 8 GB or RAM (for the two-VM tests), along with Oracle VM 2.1.1, Oracle Enterprise Linux 4.6, and Oracle Database 11*g* Enterprise Edition version 11.1.0.6.0.

Figure A shows normalized Swingbench 2.2 benchmark results measuring the performance in transactions per minute (TPM) of the physical server, an Oracle VM server running a single VM, and an Oracle VM server running two VMs simultaneously. Under a 50-user workload, a single VM could handle 93.6 percent of the database transactions handled by the physical server. As the Tolly Group noted, the single VM in these tests displayed only about 6 percent overhead—well under the 20–30 percent often considered acceptable. Under the same workload, adding a second VM resulted in a combined performance of 160.9 percent compared with the physical server, or a 67.3 percent increase for two VMs compared with one VM.

Based on these results, the Tolly Group concluded that Oracle VM could efficiently support a variety of workloads while also offering a significant degree of scalability when running multiple VMs on a single host server—enabling administrators to consolidate multiple servers running Oracle and non-Oracle applications to a single virtualized server.*

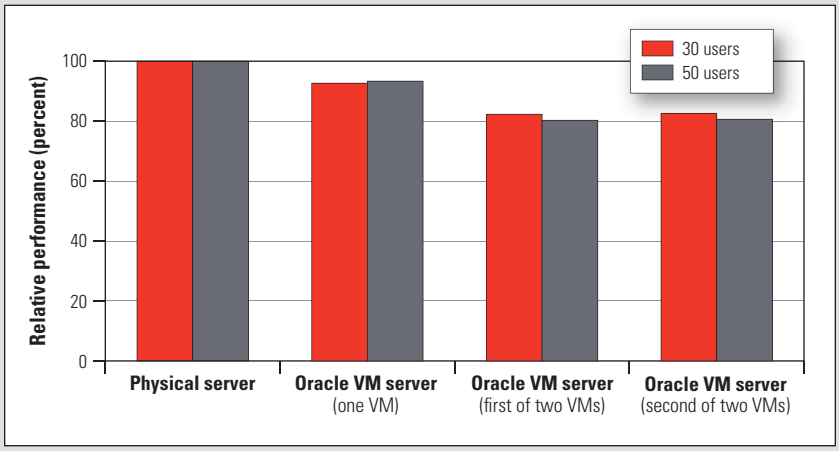


Figure A. *Normalized Swingbench 2.2 performance results comparing Oracle VM with a physical server*

*For the complete report, including additional results and details on the test configuration and methodology, see "Oracle VM: Performance Evaluation of Oracle VM Server Virtualization Software," by the Tolly Group, September 2008, www.oracle.com/technologies/virtualization/docs/ovmbenchmark.pdf.

SIMPLIFYING AND STREAMLINING CHANGE

When migrating to a new application and new tools, it can be critical to minimize the time, effort, and costs involved. Oracle VM is designed for rapid and extremely simple installation, using only a single CD application installer or a single download from Oracle.[1]

The live migration capabilities in Oracle VM enable administrators to move live VMs between physical hosts without reconfiguration or downtime. Oracle VM also encrypts migration traffic using

[1] Available at edelivery.oracle.com/oraclevm.

MAXIMIZING DELL IT EFFICIENCY WITH ORACLE VM

Oracle VM can bring multiple benefits to organizations that use Dell PowerEdge servers and Dell/EMC storage area networks (SANs)—as demonstrated by Dell itself. "For Dell IT, our deployment of Oracle VM is a critical component in driving simplicity in our environment, providing the capability to fully abstract our Oracle software deployments, both database and mid-tier, away from the underlying hardware on which it's traditionally been dependent," says Logan McLeod, senior enterprise architect on the Dell IT Database Management team.

McLeod's group has built Oracle VM server farms on Dell PowerEdge R900 servers and a Dell/EMC SAN infrastructure. "This freedom to move, resize, and dynamically reallocate server and storage resources to where they're needed most on any given day will be a game-changer in managing the life cycle of our data center infrastructure," he says.

Secure Sockets Layer (SSL) to help minimize security vulnerabilities, protect sensitive data, and avoid the need for additional hardware and dedicated networks to handle the migration.

Oracle VM also offers physical-to-virtual and virtual-to-virtual conversions, enabling administrators to quickly convert existing physical servers running Microsoft Windows or Linux or existing VMware® VMs for use with Oracle VM. For example, administrators can import VMware .vmdk images manually or using an import wizard; Oracle VM can automatically detect the image format, convert it to an Oracle VM format, and deploy it to the specified server pool.

Finally, when dealing with large, complex infrastructures, finding the right combinations of operating systems, applications, and middleware for optimal performance can be difficult—which can complicate change. Oracle VM offers two ways to simplify and streamline implementations:

- **Certification:** Oracle certifies Oracle products—including Oracle Database, Oracle Fusion Middleware, Oracle Real Application Clusters, and Oracle Applications—for Oracle VM, offering a comprehensive, certified, and supported virtualized infrastructure.
- **Oracle VM Templates:** Oracle VM Templates are preconfigured VMs containing preinstalled Oracle enterprise applications, helping organizations to rapidly deploy a configured software stack of enterprise software, from Oracle Enterprise Linux to Oracle Database, Oracle Fusion Middleware, Oracle Enterprise Manager, Oracle's Siebel Customer Relationship Management (CRM), and more.[2]

To help further simplify deployment, Dell has developed a reference architecture based on best practices for running Oracle VM 2.1 on Dell PowerEdge servers and a Dell/EMC storage area network (SAN). This architecture comprises the following components:

- A PowerEdge 1950 server running Oracle Enterprise Linux 5.1 and Oracle VM Manager
- One pool of two PowerEdge R900 servers and one pool of either two PowerEdge R805 servers or two PowerEdge R905 servers, each running Oracle VM Server; one server acts as the server pool master and Oracle VM server, while the other acts as the utility server and Oracle VM server host

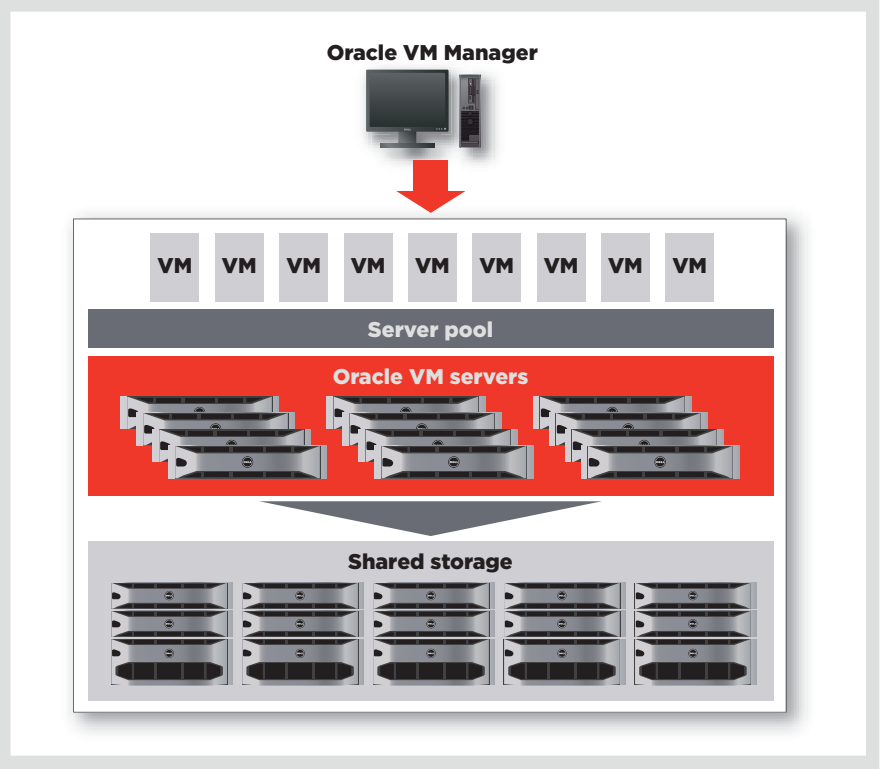


Figure 1. *Virtualized infrastructure using Oracle VM Manager, an Oracle VM server pool, and shared storage*

[2] For more information on Oracle VM Templates, visit www.oracle.com/technology/products/vm/templates.

- A Gigabit Ethernet switch for the Oracle Cluster File System 2 (OCFS2) heartbeat network
- A Gigabit Ethernet switch for the public network
- Fibre Channel switches and a Dell/EMC CX3 Series Fibre Channel SAN in a redundant configuration[3]

Figure 2 illustrates this architecture, which administrators can use to help them design and configure Oracle VM on Dell servers and storage in their own environments.

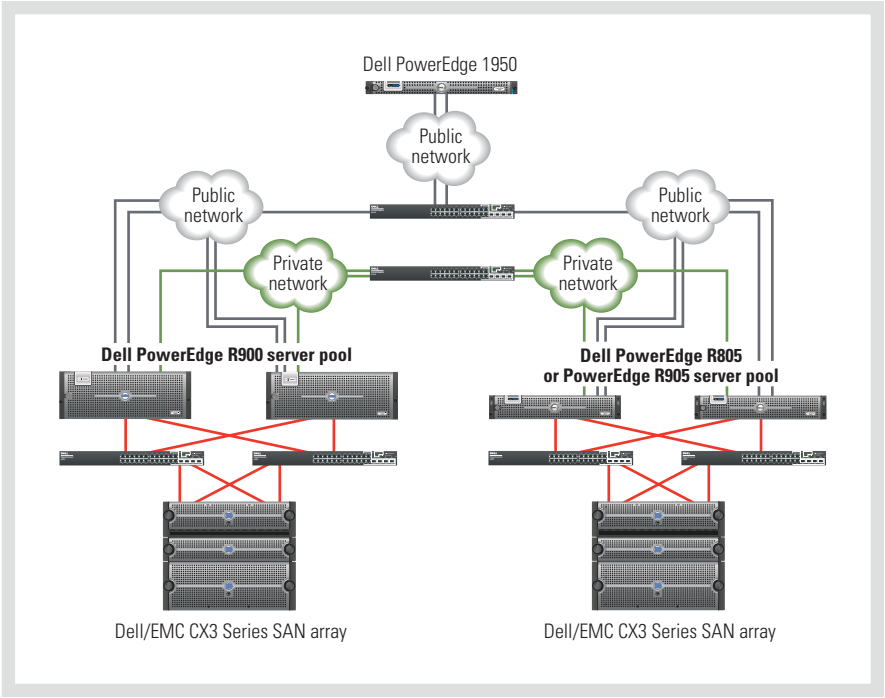


Figure 2. *Reference architecture for deploying Oracle VM on Dell servers and storage*

CREATING AN EFFICIENT INFRASTRUCTURE

As part of an overall focus on grid computing, Oracle VM enables organizations to easily and economically deploy applications in a grid without requiring physical server configuration or per-server software installation. Oracle VM can help increase server utilization through VM consolidation while helping minimize overhead and costs related to hardware, power consumption, and data center space. And through live migration, it enables administrators to easily increase or decrease the physical server resources dedicated to an application without requiring downtime.

With Oracle VM and other Oracle Grid technologies, Oracle combines the advantages of server clustering and server virtualization technologies to deliver a comprehensive grid computing infrastructure. Organizations can take advantage of integrated clustering, virtualization, storage, and management along with unified support for the virtual layer, OS, database, middleware, and applications. The combination of Oracle VM and Dell servers and storage can enable IT organizations to quickly and easily deploy operating systems and applications in a virtualized environment—helping increase flexibility, reduce total cost of ownership, and accelerate return on investment.

Rodrigo Gonzalez is responsible for the Oracle VM and Oracle Enterprise Linux channel business through Dell Americas.

Jaime Delgado is a senior director of business development at Oracle, where he is responsible for the Dell Americas partnership.

> **"With Oracle VM and other Oracle Grid technologies, Oracle combines the advantages of server clustering and server virtualization technologies to deliver a comprehensive grid computing infrastructure."**

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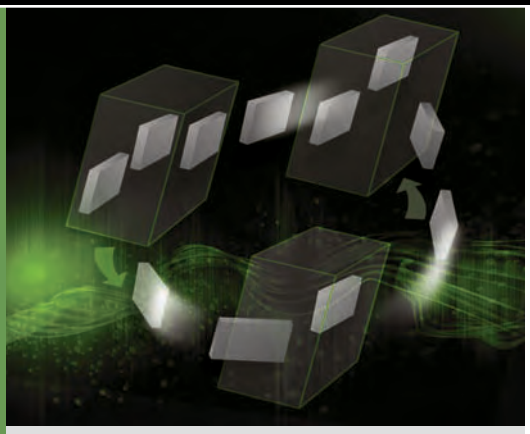
[3] For more information on this reference architecture, see "Deploying Oracle VM Release 2.1 on Dell PowerEdge Servers and Dell/EMC Storage," by Dell Inc., April 2008, DELL.COM/Downloads/Global/Solutions/ovm_ref_config_final.pdf.



MANAGING VMWARE ENVIRONMENTS IN MICROSOFT SYSTEM CENTER OPERATIONS MANAGER 2007

By Mark Carroll

Although VMware® virtualization can offer major advantages, it can also add management complexity for administrators. The nworks Management Pack for VMware from Veeam Software is designed to seamlessly integrate VMware platforms into Microsoft® System Center Operations Manager 2007—helping to centralize and simplify systems management in virtualized environments.

In many environments, managing a diverse set of hardware, software, and operating systems presents daily challenges for IT administrators. Although using virtualization to consolidate physical systems can provide a variety of advantages, it can also increase the complexity of systems management, including adding to the number of management tools that administrators must learn, deploy, and maintain. Some organizations may even avoid using virtualization in production environments because of the perceived lack of virtualization management tools that can interoperate with their existing management software.

To help simplify management in VMware environments, Veeam Software—a Dell Independent Software Vendor (ISV) Certified Partner—and Dell have teamed up to offer the nworks Management Pack for VMware. Available directly from Dell, this management pack is designed to seamlessly integrate VMware event, performance, and configuration information into Microsoft System Center Operations Manager (SCOM) 2007. For organizations using SCOM, this management pack can help accelerate virtualization adoption and the integration of VMware platforms into their existing management frameworks, centralizing and simplifying operations without requiring additional consoles, processes, or administrator training.

UNDERSTANDING THE MICROSOFT SCOM 2007 ARCHITECTURE

Microsoft SCOM 2007 is designed to help administrators measure, monitor, and manage a diverse set of physical hardware, operating systems, and applications residing on both physical systems and virtual machines (VMs). The advantage of this approach is clear: a single interface that can monitor both hardware and software, with an intuitive health-model architecture, helps to standardize how organizations manage their assets and simplify administration.

The SCOM architecture typically consists of an agent loaded on a physical system or VM, which reports back to the management server with information that is then converted into the health model. With this architecture in place, however, administrators may have legitimate concerns about incorporating separate management tools or consoles. Microsoft addresses this problem by making the SCOM architecture available for third parties to develop management packs that can fit directly into the system, helping offer a consistent management view across the enterprise.

Environments that include VMware virtualization can introduce additional complexity for enterprise management. For example, Dell™ PowerEdge™ servers running VMware ESX or ESXi hypervisors do not support typical SCOM-enabled drivers for Microsoft

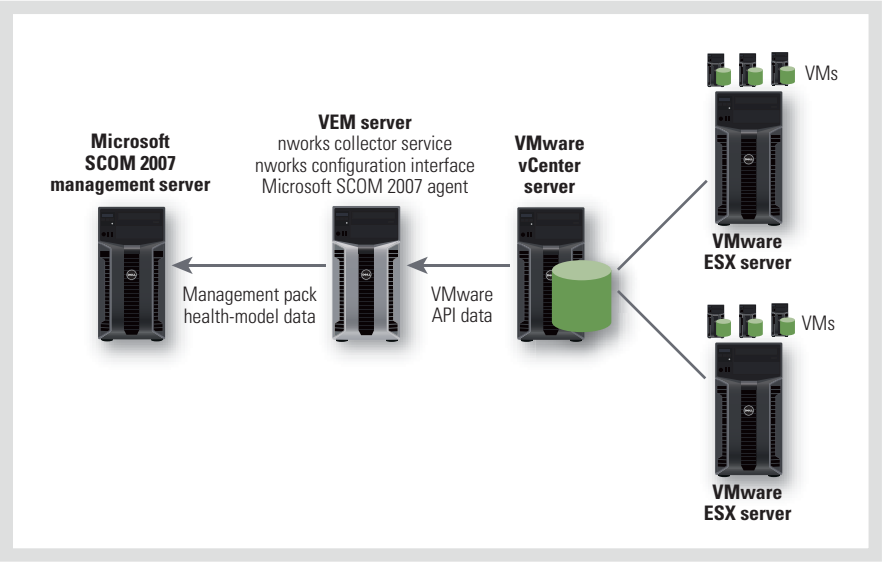


Figure 1. *Monitoring architecture for the nworks Management Pack for VMware from Veeam Software*

Windows® operating systems. VMware ESX is based on a kernel that is accessed through a console OS (COS), and ESXi requires remote access only to the kernel, leaving no place for an agent. In addition, VMware VMs use memory balloon and taxing technology in the hypervisor to allow hosts to approach upper utilization limits, essentially allowing the VMs to believe they are running at a utilization percentage that they may or may not actually be running at on the physical system—enabling enhanced attributes like memory oversubscription that can help increase physical system performance. Although this technology can have advantages for overall data center performance, it can also lead to decisions based on incorrect data at an operations management level when administrators are monitoring SCOM agents loaded on VMs.

To help overcome this problem and provide appropriate hardware and performance metrics, monitors or agents must reside at the kernel level of ESX servers. But administrators now face several resulting problems: How can they add a physical hardware agent to a system that is not running a Microsoft OS? And, furthermore, how can they add an agent to a server like the Dell PowerEdge R900, which does not require any OS when configured with ESXi—a 32 MB kernel without a COS to incorporate third-party drivers?

MANAGING VMWARE ENVIRONMENTS WITH SCOM 2007

The nworks Management Pack for VMware from Veeam Software is specifically designed to centralize and simplify management in VMware virtualized environments. Because Veeam software operates in an agentless mode, it can manage physical hardware, kernel operations, and VMs using the VMware application programming interface (API) rather than adding a COS agent or adding an agent to each VM. This management pack can also operate in read-only mode, enabling it to monitor the systems without affecting system performance.

The VMware API enables ESX or ESXi kernels to export Dell server hardware data using the Intelligent Platform Management Interface (IPMI), Common Information Model (CIM), and Systems Management Architecture for Server Hardware (SMASH) standards. The nworks Virtual Enterprise Monitor (VEM) system can gather information from multiple VMware ESX, VMware ESXi, or VMware vCenter™ Server systems, consolidate this information, convert it to the Microsoft SCOM 2007 database formatting, and forward it through a SCOM agent loaded on the VEM system (see Figures 1 and 2). The VEM is typically a physical server or VM running a Microsoft Windows 2000 Server, Windows Server® 2003, or Windows Server 2008 OS with a

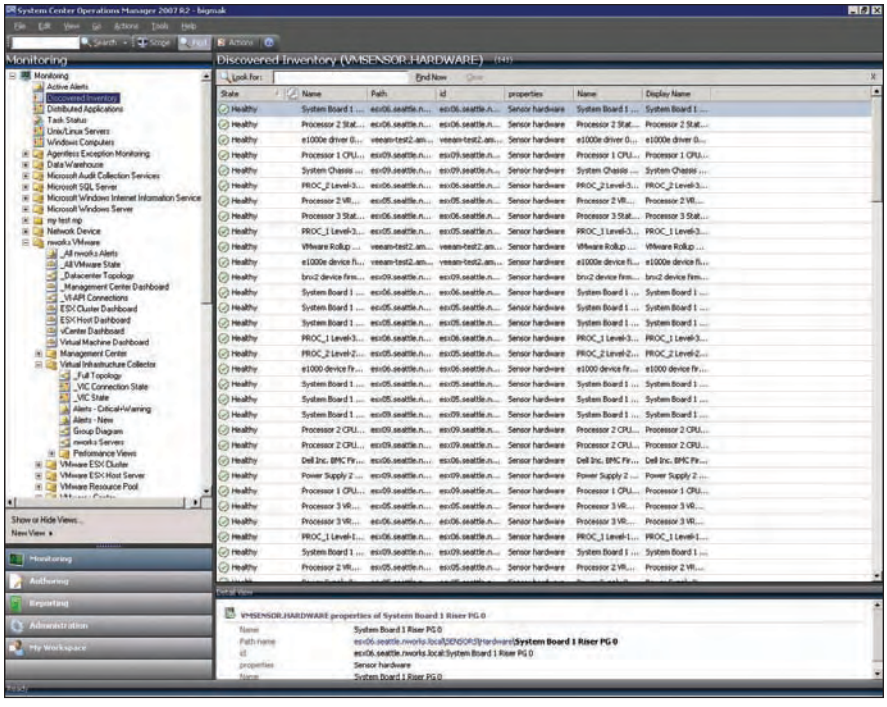


Figure 2. *Monitoring information for virtualized servers in Microsoft System Center Operations Manager 2007*

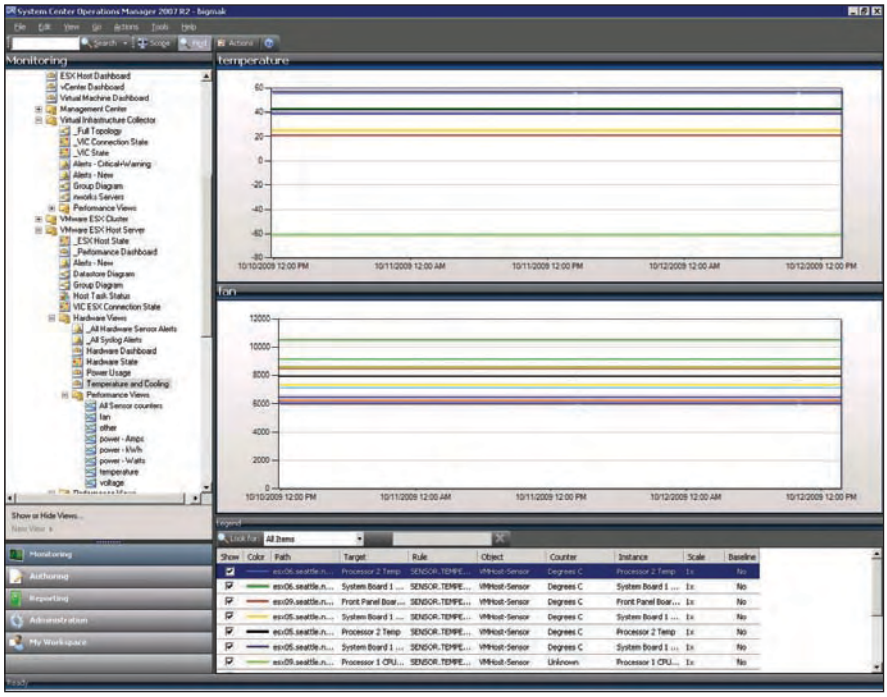


Figure 3. *Temperature and fan metrics for virtualized servers in Microsoft System Center Operations Manager 2007*

single processor and 1 GB of RAM or more. The architecture of the SCOM agent (which is designed to collect information from a single Windows-based server rather than dozens or hundreds of VMs) means that although there is no defined limit on the number of hosts or VMs that each VEM system can support, best practices recommend a configuration of up to 50 ESX or ESXi hosts per collector or up to 1,000 VMs per collector, depending on the specific environment and VEM configuration. Large enterprises can incorporate multiple VEM servers into their environments, which can then work together to support additional capacity.

After configuring the VEM system, administrators can begin monitoring and managing data from the physical hosts and VMs the same way they do for Windows-based physical servers. Within the SCOM monitoring tool, the monitoring information is displayed similarly to information from other management packs, and device integration and associations occur just as they did previously. For organizations where the systems operation staff also handles virtualization, the nworks Management Pack for VMware has integrated functionality that supports VMware Infrastructure Client operations such as putting servers into maintenance mode, turning on VMs, and suspending or shutting down VMs. This functionality also integrates with VMware user policies, enabling organizations with defined user roles to provide operations teams with appropriate levels of access.

Administrators can also use the SCOM console for trend analysis and monitoring based on current and historical data. Utilization modeling enables administrators to compare individual ESX servers to help identify whether certain systems are performing at the appropriate capacity level, and whether the VMware Distributed Resource Scheduler (DRS) and VMware High Availability (HA) capabilities are aggressive enough. Administrators can also drill down to individual hardware sensors to identify, for example, whether ambient temperatures or fan speeds may indicate a failing component—providing a warning before a systems outage occurs (see Figure 3).

Monitoring and alerting are also key elements of managing VMware environments in SCOM. The VMware kernel includes definitions to create associations with hardware events, but those definitions may not necessarily match the way a specific organization wants to set thresholds for actions. Administrators can use the SCOM interface to modify action thresholds by adjusting the preset definitions just as they would adjust other thresholds in SCOM.

SIMPLIFYING VIRTUALIZATION MANAGEMENT

Although virtualization can offer benefits ranging from reduced hardware costs to increased energy efficiency, some organizations may have avoided implementing it because of a perceived increase in management overhead. The nworks Management Pack for VMware from Veeam Software enables administrators to implement VMware virtualization in their environments while still taking advantage of their existing investments in Microsoft SCOM 2007—helping them to gain the advantages of virtualization while still maintaining a centralized, simplified console for systems management.

Mark Carroll is a solution architect for Veeam Software. He has a bachelor's degree in Management Information Systems from Baylor University, and has previously worked for both the Dell IT Group and VMware.

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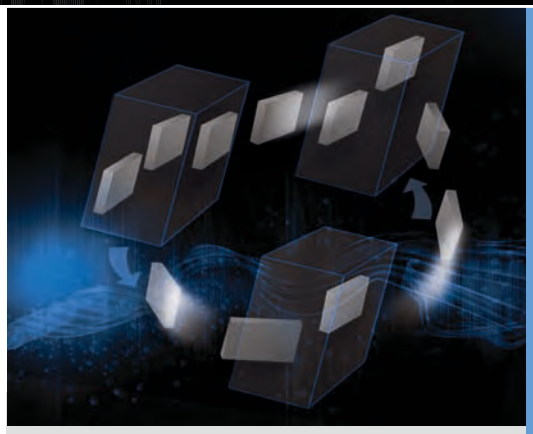
DELL INFRASTRUCTURE MANAGER AND THE VIRTUALIZATION-READY DATA CENTER



By Mahesh Natarajan

Static IT infrastructure can be difficult and time-consuming to manage, particularly when administrators must contend with multiple management tools for heterogeneous server, storage, and network provisioning. Dell™ Infrastructure Manager by Scalent offers a unified, standards-based management solution to help create a virtualization-ready data center that can adapt quickly and easily to changing enterprise needs.

One of the biggest challenges facing IT organizations is the need to rapidly adapt their IT infrastructure to meet changing enterprise demands. Most data centers today are static—administrators determine a server's function even before deploying it, and the server continues to deliver the same function regardless of usage patterns, utilization, or performance. Responding to hardware failures requires performing complex, time-consuming tasks across multiple areas of the infrastructure.

Dell Infrastructure Manager by Scalent (Dell IM) enables IT organizations to move beyond static designs toward a *virtualization-ready data center* providing an operational model for automating the infrastructure that allows change to be part of everyday activity. Using Dell IM, administrators can perform management tasks simply and efficiently, including rapidly provisioning physical servers and virtual machines (VMs), network connectivity, and storage access without manual intervention. As the foundation for a truly dynamic data center, Dell IM enables change to be the norm, not the exception, helping the IT infrastructure rapidly adjust to meet evolving enterprise needs.

INTRODUCING DELL INFRASTRUCTURE MANAGER

Dell IM is an infrastructure management and provisioning software solution that operates in the "control plane" of the data center. It interfaces with IT hardware or software using management application programming interfaces (APIs) supplied and supported by their respective vendors. This approach helps to unify control over heterogeneous infrastructure elements and offers multiple other advantages, including the following:

- **Increased responsiveness:** Dell IM helps the data center react quickly to change and helps reduce the time to fulfill IT service requests. Because time to market is critical for many business applications, this responsiveness can make substantial contributions to both the top and bottom lines.
- **Reduced capital expenditures:** Dell IM helps eliminate the need to deploy and maintain dedicated spare servers. Instead, it allows the creation of a shared pool of spare servers, one of which is automatically provisioned in the event a running server fails.

- **Increased productivity:** Automated end-to-end provisioning helps simplify and accelerate common data center tasks, including new server deployment, recovery from server failure, and change management—helping significantly increase IT staff productivity across the data center.

CREATING A VIRTUALIZATION-READY DATA CENTER

The key enabling technology in Dell IM for creating a virtualization-ready data center is the logical separation of server software—its "personality," or persona—from the actual hardware on which it runs. In this context, a server's persona is a software construct that combines the server's OS and installed applications with metadata that describes its unique properties and configuration. The persona resides in a central storage repository in its native OS format and can be booted on any suitable physical server or VM. The metadata includes a number of attributes associated with the persona that describe its connectivity, storage, and application-specific configuration.

Dell IM supports Fibre Channel storage area networks (SANs), Internet SCSI (iSCSI) targets, and network attached storage (NAS) as central repositories, as well as the associated boot mechanisms. It dynamically associates personas with suitable servers, and orchestrates changes to network connectivity and storage access. When a physical server or VM fails, a running persona is automatically retargeted to a spare server without administrator intervention. Also, by helping eliminate local disks in servers and powering down servers when not in use, Dell IM can deliver dramatic reductions in power and cooling costs.

CENTRALIZING AND AUTOMATING MANAGEMENT

Dell IM incorporates a variety of core functions to help realize the virtualization-ready data center. These features include centralized end-to-end provisioning, automated server failover, integrated virtualization management, and unified infrastructure resource management.

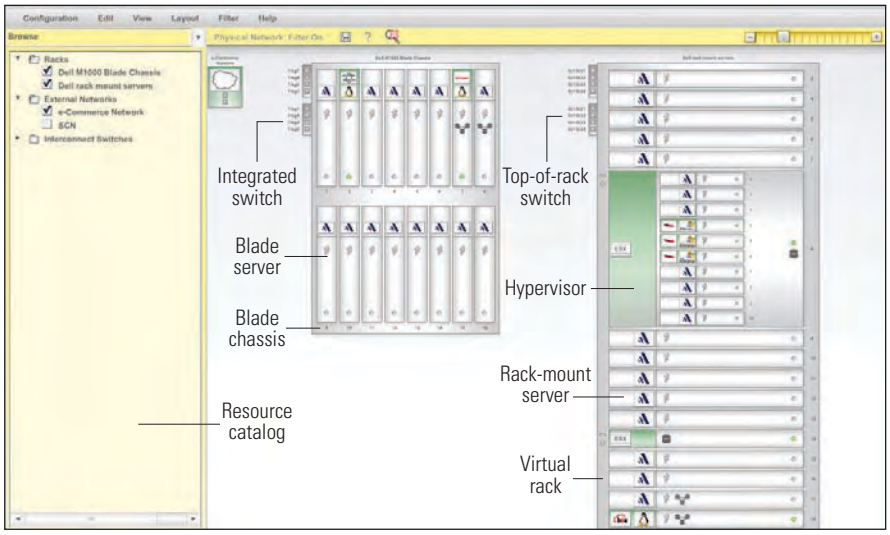


Figure 1. *Physical infrastructure in the Dell Infrastructure Manager console*

Centralized end-to-end provisioning. Dell IM enables coordinated provisioning for servers and the storage and network connectivity necessary to bring servers to a fully functional state. Rather than manually installing the OS and application image on each server's local hard disk, a central storage device (Fibre Channel SAN, iSCSI target, or NAS) is used to store and replicate server personas. After a server boots, Dell IM automatically configures the server's network connectivity—dynamically provisioning the appropriate logical network topology by securely configuring the network switches the server connects to. Dell IM also establishes the appropriate SAN connectivity for each server without circumventing SAN security and best practices.

Automated server failover. Dell IM can help protect all applications in the environment against hardware failure. Dell IM detects server failures and retargets the failed server's persona to an available spare—either a physical server or a VM. It also automatically provisions network connectivity and storage access for the spare server as it boots up. By helping eliminate the need for complex and expensive clustering solutions, Dell IM helps reduce the number of servers dedicated as standbys or spares.

Integrated virtualization management. Although virtualization has become a pervasive technology, it is often deployed in isolated islands within the data center, with management handled differently than management of the physical infrastructure. Dell IM is designed to integrate virtualization management into overall infrastructure management. It can dynamically boot bare-metal servers as Microsoft® Hyper-V™, VMware® ESX, or Red Hat® Xen virtualization hosts and manage VM provisioning on those hosts. When clusters of virtualization hosts are required, Dell IM coordinates the configuration of storage and network access shared among cluster members, and can easily increase or decrease cluster capacity as needed. Dell IM also moves server images between physical servers and VMs without conversion—offering a high degree of flexibility to dynamically target server images to an appropriate server type throughout application development, testing, and deployment phases.

Unified infrastructure resource management. Data centers often use a variety of equipment models from a variety of providers, but using specific tools to manage each type of hardware can be difficult and time-consuming. By unifying

heterogeneous equipment under a single management framework and presenting a single view of both physical and virtual resources (see Figure 1), Dell IM can deliver a dramatic boost to the efficiency of data center operations. Provisioning is designed for simplicity and ease of use, with multi-tiered applications and their associated network topologies represented in an intuitive visual way.

TRANSFORMING THE DATA CENTER

Dell IM provides a methodology for gradually transforming a data center from static to dynamic. This methodology is designed to make the transformation manageable for IT administrators, particularly in environments that must adhere to existing operational policies related to IP address administration, storage security, network access restrictions, service-level agreements, and so on.

Step 1: Automatic server discovery and remote power control. The transformation of the infrastructure begins with the installation of the Dell IM controller software, followed by automated server discovery and inventory. The controller software itself is designed to be installed on any industry-standard physical server or VM. Existing servers can subsequently be added to the environment without disrupting the applications that currently run on them. After servers have been discovered, they can be powered up or down from the Dell IM console.

Step 2: Persona creation and centralized booting. Dell IM includes tools for persona creation. This step includes migrating server images to a central storage repository and creating the persona of the migrated image. This allows the server persona to then be moved seamlessly among different servers in the data center. If a running server fails, Dell IM automatically retargets the persona to a suitable spare server and sends out an appropriate alert or message.

Step 3: Automated network topology management. The next step in the transformation process is cross-silo coordination, particularly between the server and network silos. Dell IM supports multiple modes of network management that offer increased control over the pace of and extent to which network changes are automated as server personas are deployed. Dell IM also discovers switches and selectively manages only those switch ports it is authorized to configure, and dynamically changes virtual LAN membership of switch ports during persona provisioning or retargeting.

Step 4: Automated persona configuration. The final step involves automating persona configuration and integration with other management software. The agent provides a workload configuration capability that enables administrators to define the startup and shutdown of application-related services. The agent also enables server-side networking that allows the creation of virtual network interfaces to overcome limitations of and dependencies on physical network interfaces.

UNIFYING MANAGEMENT

Managing static data center designs can be difficult and time-consuming, particularly when IT personnel must contend with an array of different hardware from different vendors, each requiring a different management tool. Dell IM offers an open, standards-based software solution designed to unify and simplify management of heterogeneous servers, storage devices, and networks—while offering a smooth migration path toward a virtualization-ready data center that can adapt quickly and easily as enterprise needs change.

Mahesh Natarajan is the director of product management at Scalent Systems.

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DESIGNING SCALABLE DELL EQUALLOGIC STORAGE FOR VIRTUALIZED MICROSOFT EXCHANGE SERVER 2007 ENVIRONMENTS

By Howard Arnold
Matt Harris
Suresh Jasrasaria
Steve Williamson

Dell has created a reference architecture for a 5,000-mailbox Microsoft® Exchange Server 2007 solution in a virtualized server environment that leverages Dell™ EqualLogic™ PS Series storage. This reference architecture is a blueprint that can be used as a building block for designing and implementing consolidated storage that offers high efficiency as well as optimal performance for enterprise deployments.

As e-mail message volume and mailbox sizes grow, organizations often struggle with the diametrically opposing goals of meeting performance demands while at the same time controlling costs. Technologies such as server virtualization and Internet SCSI (iSCSI) storage area network (SAN) arrays can help control costs by consolidating resources and enhancing efficiency—but they must be deployed using validated best practices to help ensure that performance demands are also met.

To help organizations successfully deploy Microsoft Exchange Server 2007 messaging systems in virtualized environments, Dell has created a reference architecture designed to meet the performance and capacity requirements for Microsoft Exchange Server 2007 environments that support up to 5,000 mailboxes. Dell EqualLogic PS Series iSCSI SAN arrays provide a scalable, high-performance, and efficient storage platform for the architecture. The reference architecture has been validated for functionality using both VMware® ESX[1] and Microsoft Windows Server® 2008 R2 Hyper-V™ hypervisors running on Dell PowerEdge™ servers, and validated for performance using the Microsoft Exchange Server Jetstress and Microsoft Exchange Load Generator (LoadGen) tools.

Organizations can use this reference architecture as a blueprint and a building block when designing and deploying their own virtualized Exchange Server 2007 environments using Dell PowerEdge servers and EqualLogic storage, and can scale it up or down to suit the number of mailboxes required for specific implementations. They can also use the architecture in combination with server, storage, and network sizing tools available from Dell, Microsoft, and VMware to help them pinpoint performance and capacity requirements and then map those requirements to design a server, storage, and network infrastructure that can meet their needs. By using the reference architecture as a starting point, organizations can apply a best-practices approach to meeting performance and availability requirements while reaping the benefits of efficient, cost-effective virtualization on Dell servers and storage.

UNDERSTANDING EXCHANGE PERFORMANCE AND CAPACITY SIZING

Critical to the success of Microsoft Exchange Server 2007 deployments is understanding performance and capacity requirements, and then mapping these requirements to the capabilities of a specific

[1] For details on support policies when running Microsoft applications in VMware virtual machines, visit www.vmware.com/support/policies/ms_support_statement.html.

infrastructure. For example, when designing a storage infrastructure for Exchange, two key parameters are paramount: the I/Os per second (IOPS) required for handling peak load, and total capacity required for storage. Sizing based on these parameters can be crucial to meeting performance and efficiency goals: undersized storage can lead to poor performance and outages, while oversized storage can be inefficient and costly.

To help organizations understand storage performance and capacity requirements, Microsoft offers several online tools designed to identify user profiles and then calculate IOPS and capacity requirements for Exchange Server 2007 deployments based on those profiles. Microsoft also offers guidelines on how to partition Exchange environments within a storage infrastructure.[2]

Dell followed Microsoft sizing recommendations when designing the reference architecture storage configuration based on Dell EqualLogic PS Series storage. Dell then validated that the reference architecture meets IOPS requirements using the Microsoft Jetstress and LoadGen testing tools.

Dell EqualLogic PS Series iSCSI SANs are easy to deploy and manage and are designed for high levels of capacity, performance, efficiency, and scalability

DEPLOYING SCALABLE STORAGE IN EXCHANGE ENVIRONMENTS

Dell EqualLogic PS Series iSCSI SAN arrays form the foundation of the Dell reference architecture for Microsoft Exchange Server 2007. EqualLogic arrays are designed to deliver the performance and capacity needed in Exchange deployments in combination with efficiency, scalability, and manageability. Key features include the following:

- **Linear scalability of both performance and capacity:** Business applications such as Exchange often experience tremendous growth in capacity requirements. EqualLogic arrays employ a peer architecture designed to scale storage I/O throughput linearly with disk capacity, so that added disk capacity does not reduce performance. By avoiding the need to add more capacity or performance than is necessary to meet the requirements, EqualLogic storage can provide an efficient and cost-effective storage solution.
- **Easy-to-manage growth:** Expanding capacity can be complex and lead to application performance degradation and outages. The EqualLogic peer storage architecture provides consistent scalability for a variety of deployments, enabling organizations to scale from small to very large environments simply and easily without a change in architecture and without application disruption or downtime.
- **Streamlined backup and recovery:** Sluggish backup and recovery operations can significantly reduce the performance and availability of applications such as Exchange. EqualLogic storage utilizes Microsoft Volume Shadow Copy Service (VSS) capabilities to perform rapid, off-host backup and recovery operations without affecting application performance. For example, EqualLogic Auto-Snapshot Manager/Microsoft Edition (ASM/ME)—included

> **"Dell EqualLogic PS Series iSCSI SAN arrays form the foundation of the Dell reference architecture for Microsoft Exchange Server 2007."**

[2] For more information on the Microsoft Exchange Server Profile Analyzer, visit www.microsoft.com/downloads/details.aspx?familyid=C009C049-9F4C-4519-A389-69C281B2ABDA&displaylang=en. For more information on planning storage configurations, visit technet.microsoft.com/en-us/library/bb124518.aspx. For more information on Exchange Server 2007 Mailbox server storage design, visit technet.microsoft.com/en-us/library/bb738147.aspx.

with all EqualLogic arrays at no additional cost—is designed for application-aware, off-host snapshots of Exchange environments (see the "Simplifying Exchange backup and recovery" section in this article).

SIZING THE DELL REFERENCE ARCHITECTURE

The Dell reference architecture offers a blueprint for configuring a Microsoft Exchange Server 2007 environment that supports 5,000 mailboxes sized at 512 MB each with a very heavy user activity level of 0.48 IOPS per user. These user profile and sizing guidelines have been verified by Dell using Microsoft-recommended tools.

Performance and capacity requirements

Based on the user profile and Microsoft sizing recommendations, Dell Labs calculated the baseline performance and capacity requirements to be 4,020 IOPS and 4,427 GB, respectively. The IOPS requirement is based on total user activity IOPS for the 5,000 users along with the following recommended parameters:

- 10 percent overhead for large mailboxes
- 20 percent overhead for mailbox moves, adds, and changes
- 37.5 percent overhead for log IOPS

The capacity requirement combines the total mailbox space required for the 5,000 users with the following recommended parameters:

- Room for 10 workdays of deleted item retention
- 10 percent headroom for white space
- 5 percent headroom for content indexing
- 20 percent headroom of free space for growth
- Room for 10 workdays' worth of user logs
- Room to move 500 mailboxes at a time

To help ease backup and recovery, the storage for this Exchange environment is partitioned into 20 Exchange storage groups, each with one database volume and one log volume supporting 250 users. The database volumes are sized at 147 GB (the mailbox capacity for 250 users plus 15 percent overhead) and the log volumes are sized at 30 GB (approximately 20 percent of the database volumes).

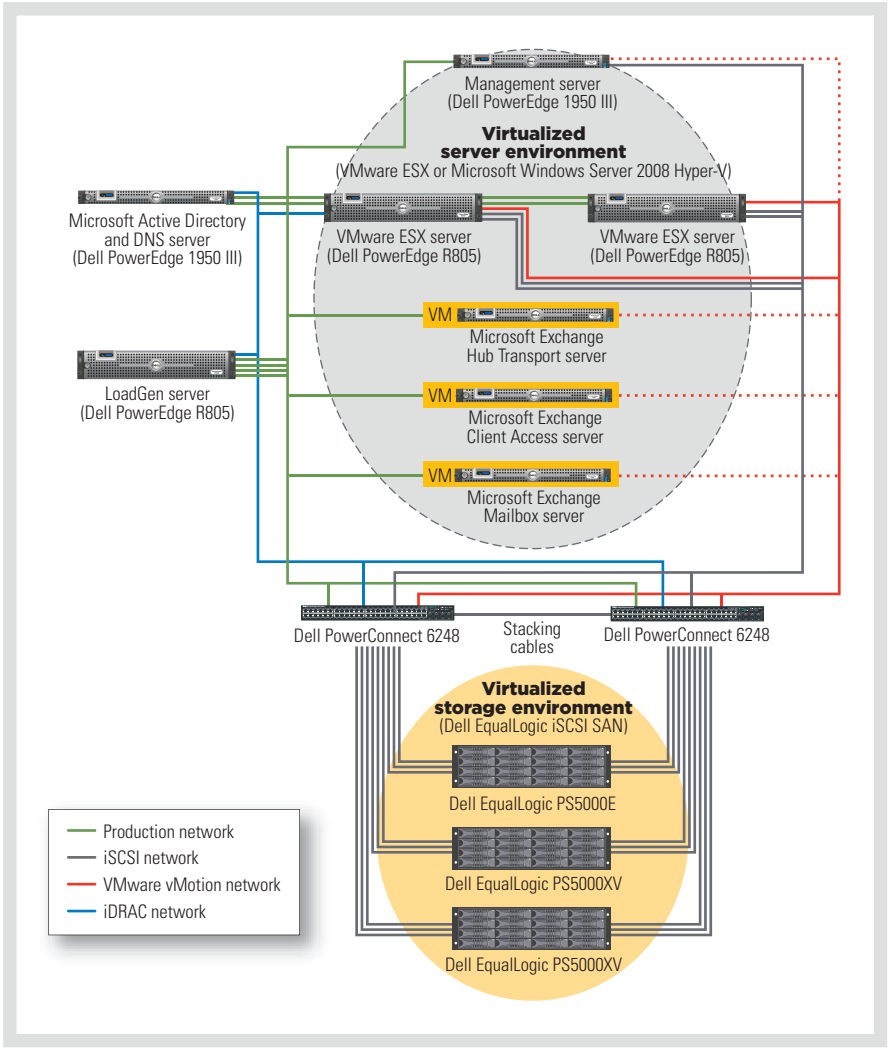


Figure 1. *Server, storage, and network topology for the Dell reference architecture*

Infrastructure components

For overall management of the virtualized Exchange environment, the reference architecture utilizes one Dell PowerEdge 1950 III server with the Microsoft Windows Server 2003 OS running VMware VirtualCenter 2.5.0 and the EqualLogic SAN HeadQuarters (SAN HQ) monitoring tool. An additional PowerEdge 1950 III running the 64-bit Microsoft Windows Server 2008 Enterprise OS serves as a Microsoft Active Directory® domain controller and Domain Name System (DNS) server (see Figure 1).

The VMware ESX hosts are two PowerEdge R805 servers with two quad-core AMD Opteron™ 2350 processors at 2.00 GHz, 32 GB of RAM, and 10 network interface cards; VMware ESX 3.5 Update 3 is also installed on a pair of mirrored local disks within each server. The virtual server environment hosted on the PowerEdge R805 servers consists of three virtual machines (VMs) running the 64-bit

Windows Server 2008 Enterprise OS and serving as the Exchange Hub Transport server, Client Access server, and Mailbox server. In the Dell Labs setup, the LoadGen validation tool was deployed on a single PowerEdge R805 server running the 64-bit Windows Server 2008 Enterprise OS.

For networking, the architecture utilizes two Dell PowerConnect™ 6248 switches stacked for iSCSI networking and three PowerConnect virtual LANs: one for production and Integrated Dell Remote Access Controller (iDRAC) traffic; one for iSCSI traffic; and one for VMware vMotion™ traffic.

The storage infrastructure consists of two Dell EqualLogic PS5000XV arrays with 450 GB, 15,000 rpm Serial Attached SCSI (SAS) hard drives in either a RAID-10 or RAID-50 configuration for database volumes, and one EqualLogic PS5000E array with 500 GB, 7,200 rpm Serial ATA (SATA) hard drives in a RAID-50 configuration for log volumes (see Figure 2). This storage configuration was chosen both to meet the calculated IOPS and capacity requirements and to leave sufficient room for growth, snapshots, and disk backups.

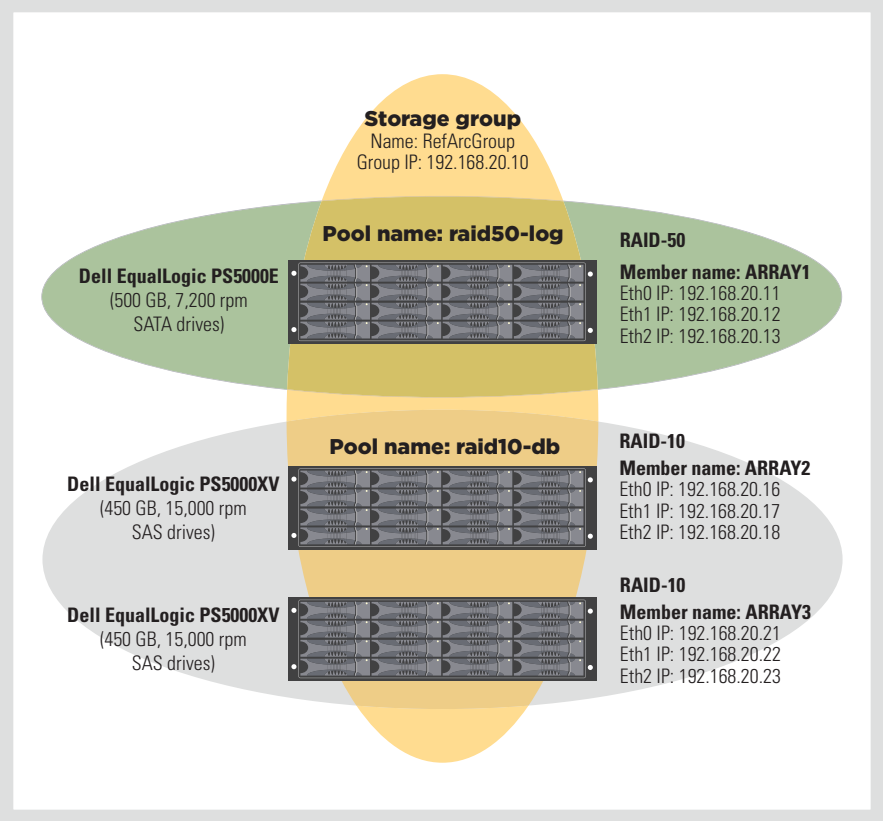


Figure 2. *Dell EqualLogic PS Series storage topology for the Dell reference architecture*

Performance validation

In June 2009, Dell engineers used the Microsoft Exchange Server Jetstress and Microsoft LoadGen utilities to test the reference architecture in both RAID-10 (run 1) and RAID-50 (run 2) configurations. The Jetstress tool simulates an Exchange disk I/O load, and was used here to validate storage performance; the LoadGen tool simulates Exchange messaging, and was used to validate server performance. The test environment used two EqualLogic PS5000XV storage arrays with a total of thirty-two 450 GB, 15,000 rpm SAS drives supporting 5,000 very heavy users with 512 MB mailboxes, and one EqualLogic PS5000E array with 500 GB, 7,200 rpm SATA drives for Exchange logs and VMware ESX data stores.

Figure 3 summarizes the configurations and results. The RAID-10 configuration provided excellent performance, achieving 5,241 IOPS—well above the 4,020 IOPS requirement, leaving plenty of room for growth. However, this configuration leaves little additional space on the arrays for snapshots and replication. The RAID-50 configuration provided good performance, achieving 4,339 IOPS. This configuration leaves little room for IOPS growth, but does leave plenty of additional capacity for snapshots and replication. Both configurations passed the LoadGen tests.

Dell EqualLogic storage sizing

The Dell reference architecture utilizes two EqualLogic PS5000XV arrays and one EqualLogic PS5000E array to support the calculated baseline requirements of 4,020 IOPS and 4,427 GB of total storage capacity. Because EqualLogic SANs

	RAID configuration	Required capacity	Maximum usable capacity	Required performance	Jetstress achieved performance	LoadGen pass/fail result
Run 1	RAID-10	4,427 GB	5,500 GB	4,020 IOPS	5,241 IOPS	Pass
Run 2	RAID-50	4,427 GB	9,400 GB	4,020 IOPS	4,339 IOPS	Pass

Figure 3. *Microsoft Jetstress and LoadGen performance results*

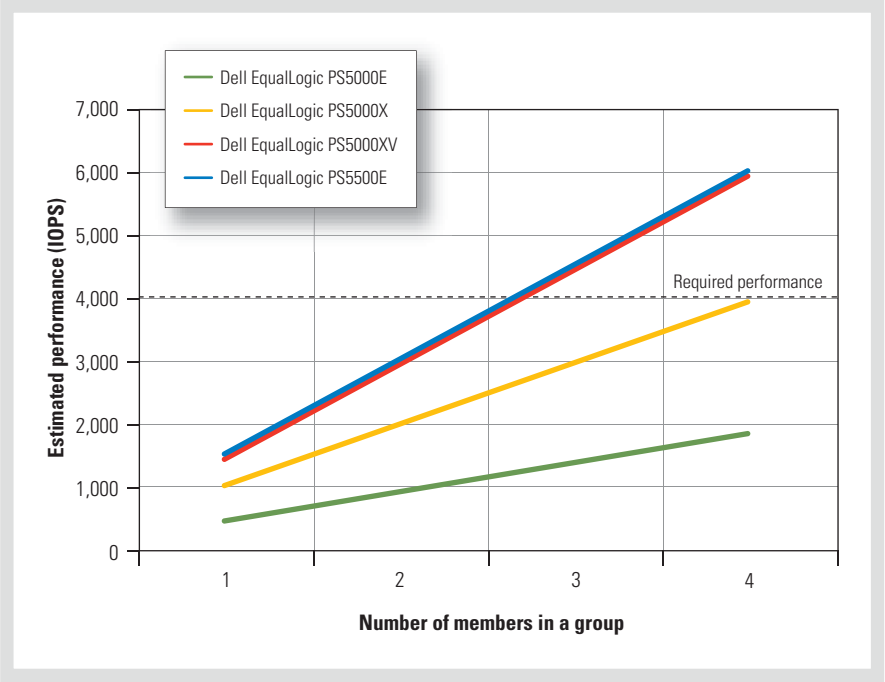


Figure 4. *Performance scalability for Dell EqualLogic PS5000 and EqualLogic PS5500 series arrays in RAID-50 configurations*

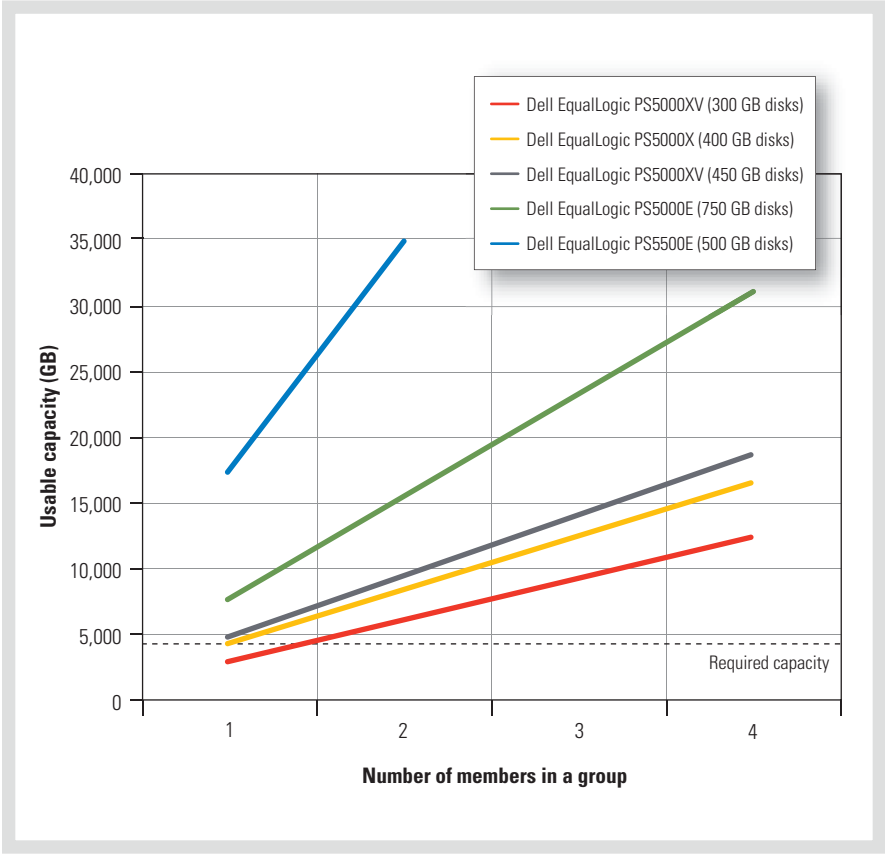


Figure 5. *Capacity scalability for Dell EqualLogic PS5000 and EqualLogic PS5500 series arrays in RAID-50 configurations*

are designed to scale performance linearly with capacity, they can be easily scaled up or down to help meet the needs of specific Exchange Server 2007 environments. The virtualization technology in EqualLogic arrays can combine the capacity from each array in a group to create virtualized pools of storage that can span one or more arrays.

To determine the appropriate EqualLogic model and disk configuration for a given Exchange deployment, organizations should first determine their total performance (IOPS) requirements, then select the model and number of arrays accordingly. For example, Figure 4 shows the estimated performance scalability of different EqualLogic PS5000 and EqualLogic PS5500 series arrays in a RAID-50 configuration supporting 5,000 very heavy users as in the Dell reference architecture, based on an internal Dell sizing tool. In this case, EqualLogic PS5000XV or EqualLogic PS5500E arrays in a three-member configuration can exceed the performance requirement of 4,020 IOPS; the EqualLogic PS5000XV and EqualLogic PS5000E arrays were selected for the reference architecture. Figure 4 also shows that adding arrays to a storage pool helps increase performance linearly with the added capacity.

After choosing a model, organizations can then select a disk capacity and number of arrays to meet total capacity requirements. Figure 5 shows capacity options for different EqualLogic PS5000 and EqualLogic PS5500 series arrays in a RAID-50 configuration supporting 5,000 very heavy users as in the Dell reference architecture. Any of the disk sizes and models shown can provide sufficient capacity in a two-member configuration; the 450 GB disks in the EqualLogic PS5000XV were chosen for the reference architecture to help maintain sufficient capacity headroom.

SIMPLIFYING EXCHANGE BACKUP AND RECOVERY

Dell EqualLogic ASM/ME uses Microsoft VSS to provide a framework for backing

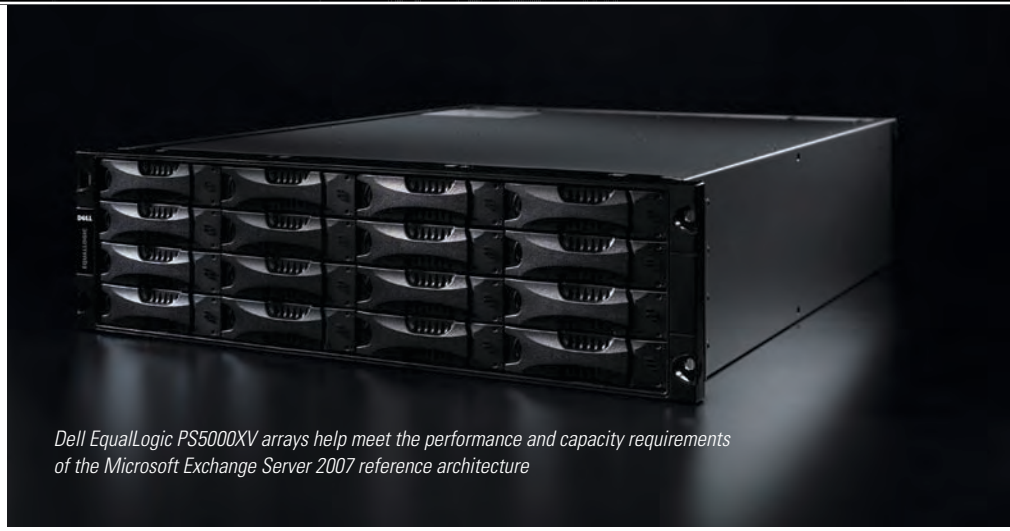
up and restoring data in Microsoft Windows Server environments. ASM/ME enables administrators to easily create space-efficient point-in-time, consistent copies of application data in an EqualLogic PS Series group. While copies are created, the applications remain online, and there is little impact on performance and application availability. EqualLogic PS Series groups can store both application data and snapshot copies to facilitate quick and efficient recovery.

ASM/ME is not a replacement for a regular and complete backup of data to long-term media, but rather can enhance and supplement a regular backup regimen by providing rapid, efficient data recovery. Administrators can also use backup software to transfer the data in Smart Copies to long-term backup media. Because the applications in the production environment can remain online during such transfers, ASM/ME helps significantly reduce planned downtime.

The use of an off-host verification server for soft recovery and checksum validation is strongly recommended when using ASM/ME with Exchange. The off-host server mounts the snapshots and performs the soft recovery and checksum verification, thus offloading these tasks from the production Exchange server.

CREATING A SCALABLE BLUEPRINT FOR EXCHANGE DEPLOYMENTS

As shown by the Jetstress and LoadGen testing results, the Dell reference architecture for virtualized Microsoft Exchange Server 2007 deployments can support up to 5,000 very heavy users with 512 MB mailboxes, delivering ample performance and capacity in both RAID-10 and RAID-50 configurations. Organizations can use the architecture described in this article as a blueprint for designing and sizing their own virtualized Exchange Server 2007 messaging infrastructures. These best practices can be used in combination with server, storage, and network sizing tools to help identify performance and capacity requirements, and organizations can further customize the design to help meet specific performance and availability needs while reaping the efficiency and cost benefits of virtualization and iSCSI SANs.



Dell EqualLogic PS5000XV arrays help meet the performance and capacity requirements of the Microsoft Exchange Server 2007 reference architecture

Howard Arnold is a solutions architect in the NDC Enterprise Solutions Support Group within the Dell Global Commercial Support Services Group. Before joining Dell, Howard worked for more than 20 years designing and delivering professional services solutions for companies such as Digital Equipment Corporation; Celerent, Inc.; and Expert Server Group.

Matt Harris is a solutions architect in the NDC Enterprise Solutions Support Group within the Dell Global Commercial Support Services Group. Before joining Dell, Matt worked in the professional services industry for more than 20 years managing and delivering professional services globally to customers for Digital Equipment Corporation and Celerent, Inc. Matt was a principal and cofounder of Celerent, Inc.

Suresh Jasrasaria is a product marketing senior consultant in the Dell Enterprise Storage Product Group. Before joining Dell, Suresh worked in the data storage industry for more than 20 years at organizations such as EMC, Veritas, and Digital Equipment Corporation. Suresh has a bachelor's degree in Electrical Engineering from the Indian Institute of Technology Kanpur, a master's degree in Computer Science from the University of Toronto, and an M.B.A. from Boston College.

Steve Williamson is the manager of the NDC Enterprise Solutions Support Group within the Dell Global Commercial Support Services Group. Steve joined EqualLogic in June 2007 prior to Dell's acquisition, before which he worked in a number of technical support and product development roles in both the United States and Europe. Steve has also previously worked for EMC as the director of global customer support, later establishing a European-based implementation service for professional services and working on product management within EMC's Symmetrix engineering group.

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F5 LOAD BALANCING FOR MICROSOFT OFFICE COMMUNICATIONS SERVER 2007 R2

By Fred Johnson
Akshai Parthasarathy

In large deployments of Microsoft® Office Communications Server 2007 R2, high availability and scalability can be critical. By using F5® BIG-IP® Local Traffic Manager™ systems for hardware load balancing and adhering to recommended best practices, administrators can create robust, highly available, highly scalable unified communications architectures.

Microsoft Office Communications Server 2007 R2 (OCS R2) is designed for enhanced instant messaging, presence, voice and video, conferencing, e-mail, voice mail, and fax communications from mobile workstations. It uses packet-switched communication through Session Initiation Protocol (SIP) and Secure Real-Time Transport Protocol (SRTP) over a data network, and can also integrate with private branch exchange (PBX) phone systems.

In large production deployments of OCS R2, ensuring high availability and scalability can be critical to success. Best practices recommend using hardware load balancing to help meet this requirement for the front-end server pools, directors, Microsoft Office Communicator Web Access (CWA) servers, and edge servers. This article provides an example architecture, configuration details, and best practices for using F5 BIG-IP Local Traffic Manager (LTM) systems to implement hardware load balancing in large OCS R2 deployments.

EXAMPLE MICROSOFT OCS R2 LOAD-BALANCING ARCHITECTURE

Figure 1 shows the primary components of an example Microsoft OCS R2 Enterprise Edition architecture incorporating F5 BIG-IP LTM hardware load balancing. In this architecture, client systems that log on from the internal network register with the front-end servers; these servers also handle instant messaging and call routing along with a number of other co-located services such as OCS R2 application services, audio/video conferencing, and Web conferencing. The CWA servers enable end users to access Communicator features using a supported Web browser over a secure channel. Load-balanced edge servers direct SIP traffic to the director array. A director within that array then authenticates requests made from the external network and routes traffic to the front-end servers.

The BIG-IP LTM load balancers in this architecture help distribute application traffic, such as SIP and HTTP over Secure Sockets Layer (HTTPS), across multiple servers. Load balancing can help increase application capacity, fault tolerance, and overall performance by decreasing the server overhead associated with managing application connections, traffic optimizations, and encryption offload.

F5 BIG-IP LTM CONFIGURATION

Load balancing a Microsoft OCS R2 deployment requires a variety of F5 BIG-IP LTM features, including virtual servers, profiles, Secure Network Address Translation (SNAT), and pools. Administrators can access these features through the BIG-IP LTM management interface using a Web browser over an HTTPS connection.

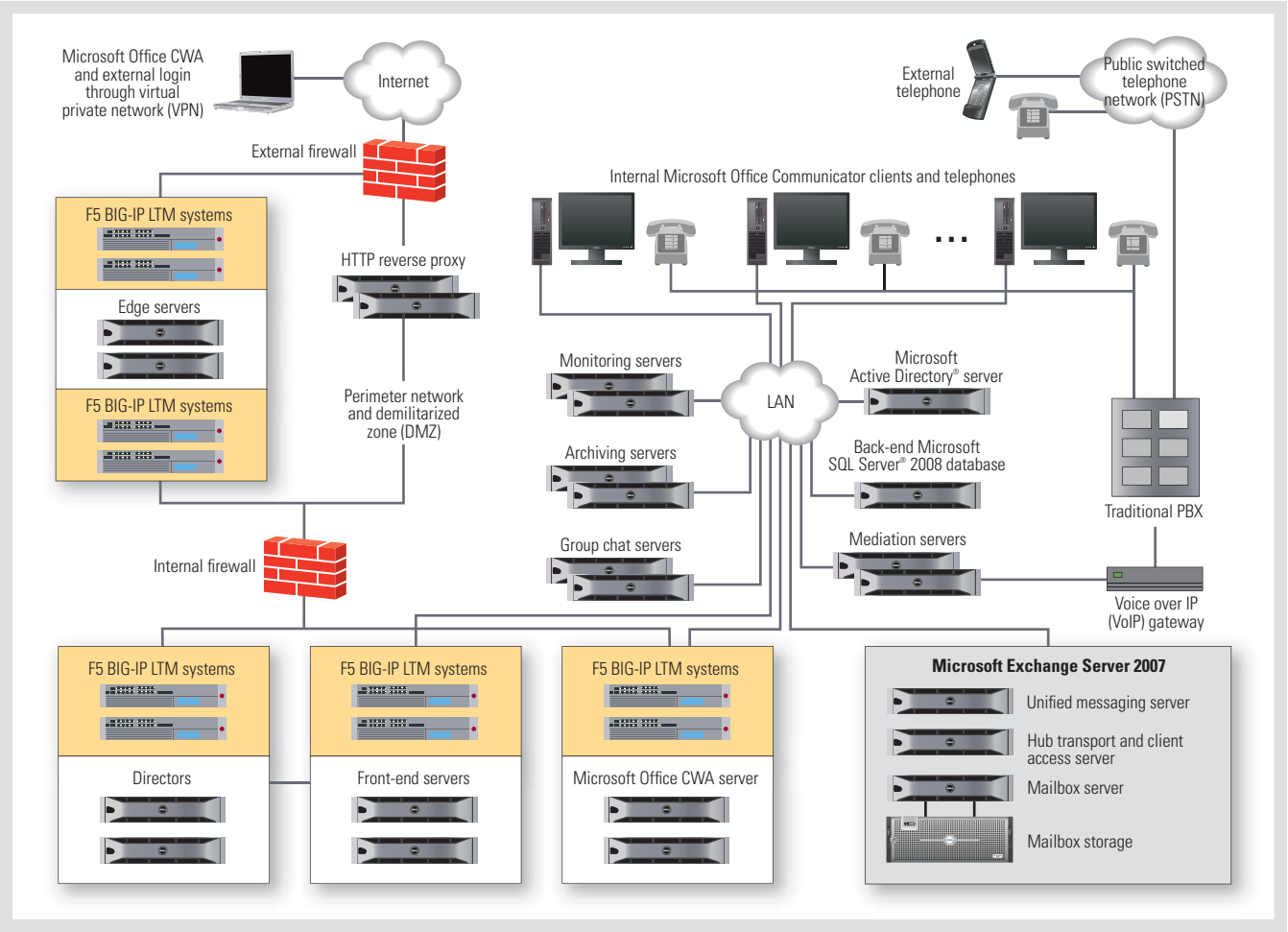

Figure 1. *Microsoft Office Communications Server 2007 R2 architecture with F5 BIG-IP Local Traffic Manager systems*

OCS R2 hardware load balancing requires that administrators allow certain ports and protocols to be load balanced on the BIG-IP LTM systems. For example, the front-end servers, directors, and edge servers must be enabled for TCP or Mutual Transport Layer Security (MTLS) traffic through ports 5060 and 5061, respectively.

Health monitors are used to check the availability of OCS R2 services in the server pools. For example, the health monitors for ports 443, 3478, 5061, and 5062 must be configured for the edge servers. Following the creation of the health monitors, pools are created and assigned with health monitors. A separate health monitor and pool are created for each service port.

The final features to set up are the virtual servers and TCP profiles. TCP profiles allow administrators to customize the TCP idle time-out for each virtual server. The virtual server is essential for signaling using SIP and for Web traffic. For example, the CWA virtual server uses port 443 for load balancing Web traffic from the CWA clients.[1] After the virtual server is configured, administrators must manually update the Domain Name System (DNS) to associate the BIG-IP LTM virtual IP address with the pool's fully qualified domain name (FQDN) specified in the OCS R2 deployment steps.

Figure 2 shows two Communicator clients sending requests to the front-end server pool; the first client is load balanced to front-end server 1, while the second, which logs on shortly afterward, is forwarded to front-end server 2 using the Least Connections (node) load-balancing method. In this example, the SNAT address of 192.168.1.16 is used for communication with the front-end server pool.

BEST PRACTICES FOR MICROSOFT OCS R2 DEPLOYMENTS

Adhering to recommended best practices can help ensure a successful deployment of Microsoft OCS R2 with F5 BIG-IP LTM hardware load balancing:

- Use the BIG-IP LTM high-availability mode to provide application fault tolerance for OCS R2. This mode requires two BIG-IP LTM systems and additional

[1] For more information on ports and protocols for virtual servers, visit technet.microsoft.com/en-us/library/dd425238(office.13).aspx.

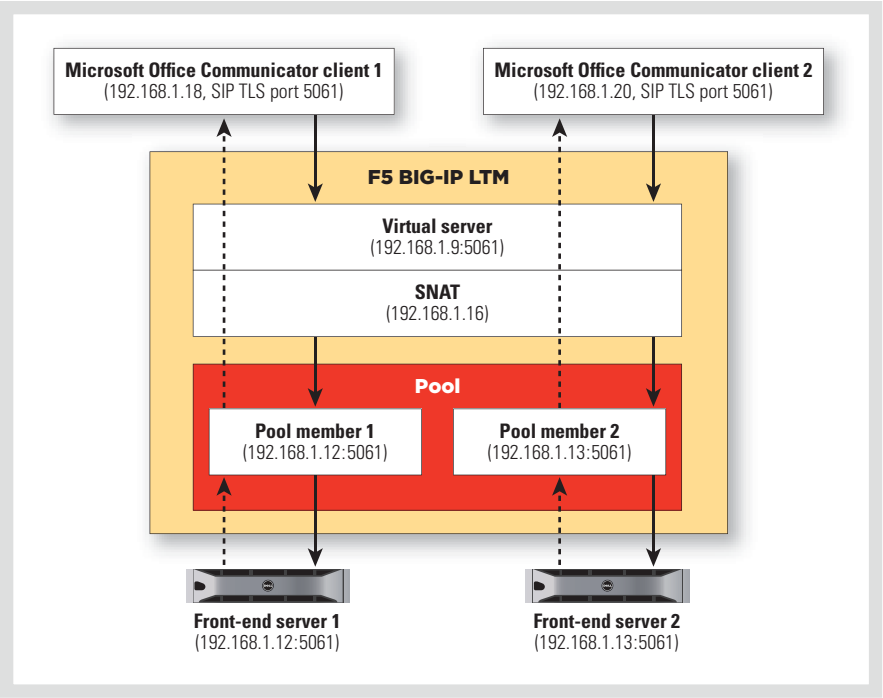

Figure 2. *Load-balancing configuration for two Microsoft Office Communicator clients*

configuration to complete the setup, which can include Media Access Control (MAC) masquerading, configuration synchronization, and connection mirroring.

- Use the Least Connections (node) load-balancing method, which specifies that the BIG-IP LTM systems should pass new connections to the node that has the fewest number of current connections. Load-balancing calculations can be localized to each pool (a member-based calculation) or can apply to all pools of which a server is a member (a node-based calculation).
- Use BIG-IP LTM Secure Sockets Layer (SSL) acceleration to offload the HTTPS encryption processing from the CWA servers and help reduce processor utilization. Administrators can enable SSL acceleration by first enabling the CWA servers to process HTTP (instead of HTTPS), and then loading a certificate on the BIG-IP LTM system and associating that certificate with the SSL profile.
- For CWA servers, use the recommended TCP idle time-out value of 1,800 seconds; for front-end server load balancing, use a value of 1,200 seconds. This value specifies the number of seconds that a TCP connection to a virtual server can remain inactive before the load balancer closes the connection.
- For CWA servers, use the Least Connections (node) load-balancing method and HTTP cookie insert persistence, which helps ensure that when a client is load balanced to a pool member, future connections from that client are directed to the same member, and also allows session affinity between the clients and servers. Simple or SSL session ID persistence can be used to help ensure that SIP over Transport Layer Security (TLS) connections to a front-end server maintain affinity.
- Use a SNAT pool when handling more than 65,000 simultaneous connections. A SNAT pool allows the grouping of SNAT addresses, each of which can accommodate only 65,000 connections. SNAT is required for load balancing front-end server pools in OCS R2 Enterprise Edition, and can map multiple CWA or Communicator client IP addresses to a translation address defined on a BIG-IP LTM system.

ROBUST LOAD BALANCING FOR MICROSOFT OCS R2

For large deployments of Microsoft OCS R2, using hardware load balancers can help maintain high availability and scalability for the front-end server pools, directors, CWA servers, and edge servers. Using the robust features of F5 BIG-IP LTM systems and adhering to recommended best practices for configuring and deploying those systems can help organizations successfully implement hardware load balancing in enterprise environments.

Fred Johnson is a strategic partner engineer with F5 Networks dedicated to Dell Labs, and works closely with Dell development and services groups on proof-of-concept designs, benchmarks, technical publications, and training involving Dell, F5, and third-party software products. He has 20 years of experience in IT and has a B.A. in Psychology from the University of Texas at Austin.

Akshai Parthasarathy is a systems engineer working on Dell Unified Communications and Microsoft Exchange solutions as part of the Dell End-to-End Solutions team. His current interests include performance characterization and sizing for these two Dell solutions. Akshai has a bachelor's degree and a master's degree in Electrical and Computer Engineering from the Georgia Institute of Technology.

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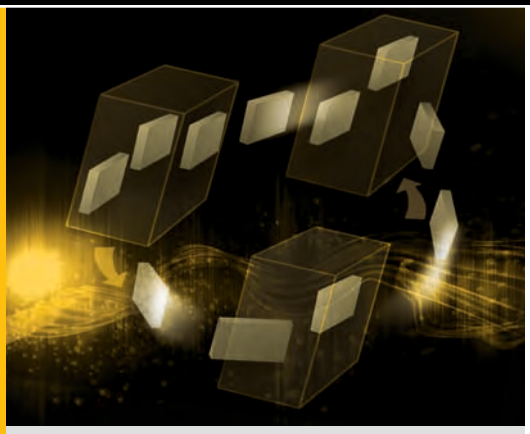


STREAMLINING STORAGE MANAGEMENT WITH VIRTUALIZATION-AWARE EMC NAVISPHERE MANAGER ON DELL/EMC CX4 ARRAYS

By Annette Cormier
Andrew Gilman

By providing automatic end-to-end mapping of virtual machines to the physical servers and storage supporting them, virtualization-aware EMC® Navisphere® Manager software on Dell/EMC CX4 Series storage arrays helps dramatically increase resource efficiency and simplify storage administration tasks such as problem diagnosis, change management, and capacity planning.

When organizations transition to virtualized environments, efficient and effective management of storage resources can be a particular challenge. Many storage management tools are designed for traditional, non-virtualized environments in which the relationship between servers and storage resources is static and one to one. Virtualization, however, abstracts servers, operating systems, and applications from the physical hardware that supports them, rendering them inaccessible to most storage management tools. As a result, storage administrators typically lack visibility into how the virtualized server environment is configured and which virtual machines (VMs) are consuming which storage resources. Similarly, system administrators typically lack visibility into the storage infrastructure and which storage resources are assigned to support which VMs.

This visibility gap between VMs and storage resources can dramatically increase the time and effort required to manage storage resources in virtualized environments, making typical storage management tasks such as problem diagnosis, change management, and capacity planning nearly impossible. For example, administrators often have no choice but to manually correlate VMs with underlying storage resources, which can take an enormous amount of time and lead to inefficient use of resources and suboptimal performance. In large organizations that employ dedicated server, storage, and networking administrators, correlating VMs with storage is even more complex, requiring often cumbersome coordination between administrative staffs. These management challenges must be addressed before organizations can capitalize on virtualization's many benefits.

Virtualization-aware EMC Navisphere Manager software for Dell/EMC CX4 Series storage arrays helps organizations simplify the task of managing storage in a virtualized environment. Navisphere Manager bridges the virtual-to-physical management gap by providing the much-needed link between VMs and the storage resources that support them. Navisphere Manager performs end-to-end mapping of VMware® virtualized environments, and provides both storage administrators and VMware administrators with comprehensive visibility into physical and virtual infrastructures. Navisphere Manager leverages VMware vCenter™ Server application programming interfaces (APIs) to correlate VMware VMs with physical storage resources automatically and in real time. By helping avoid the need to manually correlate VMs with storage resources, virtualization-aware Navisphere Manager enables administrators to dramatically simplify storage management tasks such as problem diagnosis, change management, and capacity planning to enhance the efficiency and performance of virtualized environments (see the "Optimizing virtualization performance and efficiency" sidebar in this article).

OPTIMIZING VIRTUALIZATION PERFORMANCE AND EFFICIENCY

Many organizations have turned to virtualization as a way to optimize server and storage resource utilization, and are deploying mission-critical applications such as Oracle® Database and Microsoft® Exchange software in virtualized environments. For these types of large-scale enterprise applications, performance and availability are paramount; however, helping to ensure application demands are met and optimized for efficiency can be a challenge for server and storage administrators.

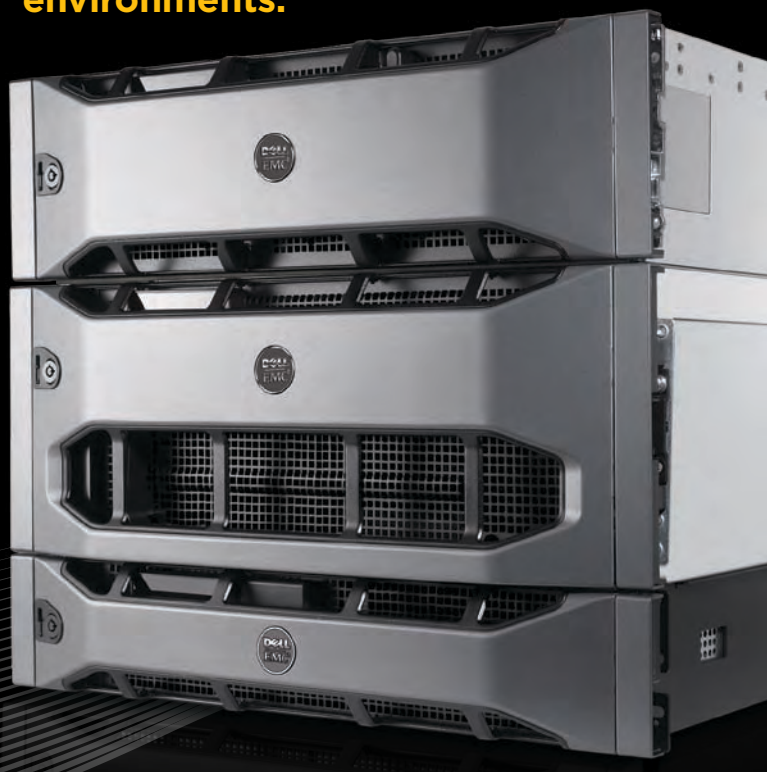
Dell/EMC CX4 Series storage arrays are designed specifically to enhance efficiency and optimize application performance in VMware virtualized environments. Key features of Dell/EMC CX4 Series storage arrays include virtual provisioning, flexible connectivity, and advanced integration capabilities.

Virtual provisioning helps administrators allocate storage capacity simply and automatically on an as-needed basis as opposed to all at once. Flexible connectivity provides administrators with the ability to mix Internet SCSI (iSCSI) and Fibre Channel connectivity options in the same system using the EMC UltraFlex™ architecture, including support for leading-edge 10 Gbps iSCSI and 8 Gbps Fibre Channel. Advanced integration capabilities through the VMware vStorage application programming interface (API) enables storage vendors to optimize the performance and maximize the efficiency of storage resources in virtualized environments. Dell/EMC CX4 Series storage arrays take advantage of vStorage capabilities in a range of ways, including the following:

- **Virtualization-aware EMC Navisphere Manager:** Available with Dell/EMC CX4 Series arrays, this application is designed to streamline storage management by providing end-to-end virtual-to-physical mapping of virtualized environments.
- **EMC PowerPath/VE:** This technology helps maximize performance by delivering EMC PowerPath® multipathing features for automating optimal server, storage, and path utilization in a dynamic virtualized environment, which also helps avoid the need to manually balance loads.
- **Storage area network (SAN)–based replication, snapshot, and recovery:** Tools such as the VMware vCenter Site Recovery Manager, EMC SnapView™, EMC SAN Copy™, and EMC Replication Manager applications are integrated with vStorage APIs to help offload backup and recovery operations from a virtualized server to the SAN, freeing up valuable server processor resources.
- **Integration with management tools:** EMC Navisphere Manager is integrated into several leading-edge management tools, including the Dell OpenManage™ systems management suite, the Oracle Enterprise Manager application management suite, the Veritas™ NetBackup™ data management tool from Symantec, and IBM® Tivoli software, as well as software from CommVault and Computer Associates. This end-to-end integration of management tools is designed to provide visibility into data center infrastructures from the point of view of any administrator.

By providing a range of features designed specifically for VMware virtualized environments, Dell/EMC CX4 Series arrays offer organizations an excellent storage choice for virtualized environments that require the performance, availability, and efficiency to support mission-critical, enterprise-scale applications.

"Dell/EMC CX4 Series storage arrays are designed specifically to enhance efficiency and optimize application performance in VMware virtualized environments."



> **"Virtualization-aware EMC Navisphere Manager for Dell/EMC CX4 Series storage arrays helps organizations simplify the task of managing storage in a virtualized environment."**

ADDRESSING STORAGE MANAGEMENT CHALLENGES

The lack of visibility between VMs and the storage resources that support them can force administrators to manually perform many key storage management functions, including problem diagnosis, change management, and capacity planning. In addition to being complex and time-consuming, manual processes for these tasks can also be error prone and inefficient.

If a VM is underperforming, for example, administrators may have no way to automatically identify which storage resources, or logical units (LUNs), are supporting that VM. As a result, administrators must manually copy information from VM management applications to storage management applications to make this connection. This manual process is not only time-consuming, but can also make it difficult to meet performance requirements.

Similarly, in a typical virtualized environment, mapping VMs to LUNs to validate changes to the infrastructure must be done manually—a task that can involve viewing literally hundreds of screens. For example, in a VMware environment of 100 VMs spread across 10 VMware ESX servers, hundreds of screens would be required to map VMs to LUNs. The resulting data would then have to be manually recorded, and any change to the environment would require administrators to repeat this arduous task. Often, administrators resort to simply not moving VMs to avoid the recording and management headache, which can lead to inefficient use of resources and suboptimal performance.

Capacity planning is also complex in a virtualized environment. Determining how much storage has been committed to and is being used by individual VMs for a given LUN to help ensure enough space is allocated requires time-consuming manual correlation among LUNs, ESX servers, and VMs. As with other storage management tasks, failure to perform capacity planning can lead to performance bottlenecks and inefficiency.

BRIDGING THE VIRTUAL-TO-PHYSICAL MANAGEMENT GAP

To help simplify the tasks associated with managing storage in virtualized environments, Dell offers the virtualization-aware EMC Navisphere Manager application, a storage management tool for Dell/EMC CX4 Series storage arrays that helps bridge the gap between physical storage and VMware virtualized environments. By leveraging VMware vCenter Server APIs, Navisphere Manager supports the automatic management, discovery, and reporting of VMware virtualized infrastructures.

To perform these functions, Navisphere Manager automatically discovers VMs managed in the vCenter Server environment and correlates them to the physical server and storage resources that support them (see Figure 1). Storage administrators can then use Navisphere Manager to view the entire virtual-to-physical topology, including the relationships between VMware VMs, disk files, data stores, and underlying LUNs. Administrators can also use Navisphere Manager to easily identify which VMs are using which LUNs and vice versa, and can search for individual VMs by name as well.

Navisphere Manager also offers VMware administrators visibility into the storage infrastructure through the complimentary EMC Storage Viewer plug-in for vCenter. Together, Navisphere Manager and the EMC Storage Viewer plug-in offer common end-to-end visibility into both physical and virtual infrastructures for storage administrators and VMware administrators.

By providing the ability to automatically map and report on virtual-to-physical relationships, Navisphere Manager can dramatically simplify storage management tasks such as troubleshooting, change management, and capacity planning:

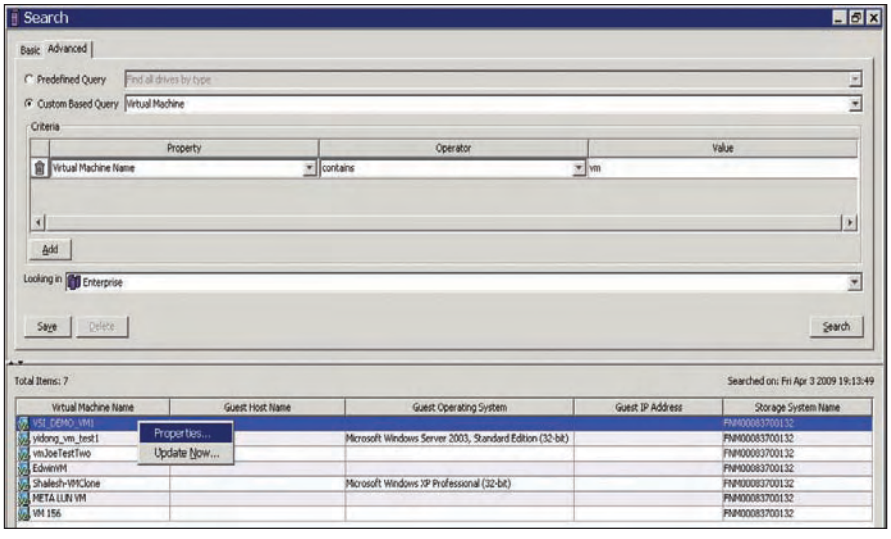
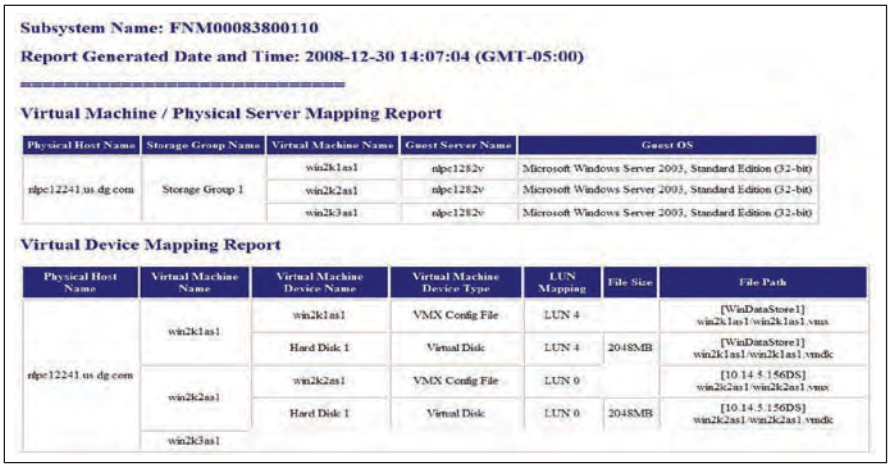


Figure 1. *Viewing discovered virtual machines after performing a search in EMC Navisphere Manager*



Subsystem Name: FNM00083800110

Report Generated Date and Time: 2008-12-30 14:07:04 (GMT-05:00)

Virtual Machine / Physical Server Mapping Report

Physical Host Name	Storage Group Name	Virtual Machine Name	Guest Server Name	Guest OS
nlpc12241.us.dg.com	Storage Group 1	win2k1as1	nlpc1282v	Microsoft Windows Server 2003, Standard Edition (32-bit)
		win2k2as1	nlpc1282v	Microsoft Windows Server 2003, Standard Edition (32-bit)
		win2k3as1	nlpc1282v	Microsoft Windows Server 2003, Standard Edition (32-bit)

Virtual Device Mapping Report

Physical Host Name	Virtual Machine Name	Virtual Machine Device Name	Virtual Machine Device Type	LUN Mapping	File Size	File Path
nlpc12241.us.dg.com	win2k1as1	win2k1as1	VMX Config File	LUN 4		[WinDataStore1] win2k1as1/win2k1as1.vmx
		Hard Disk 1	Virtual Disk	LUN 4	2048MB	[WinDataStore1] win2k1as1/win2k1as1.vmdk
	win2k2as1	win2k2as1	VMX Config File	LUN 0		[10.14.5.156DS] win2k2as1/win2k2as1.vmx
		Hard Disk 1	Virtual Disk	LUN 0	2048MB	[10.14.5.156DS] win2k2as1/win2k2as1.vmdk
	win2k3as1					

Figure 2. *Viewing a report mapping virtual machines to LUNs in EMC Navisphere Manager*

- **Simplified troubleshooting:** To address the traditionally tedious and time-consuming task of identifying which storage resources are supporting an underperforming VM, virtualization-aware Navisphere Manager enables storage administrators to search for an underperforming VM by name. Navisphere Manager identifies and displays which LUNs that VM is using, and also provides detailed processor, networking, and capacity information. Administrators can use this information to help them quickly diagnose and resolve problems.
- **Streamlined change management:** To help validate infrastructure changes, Navisphere Manager enables administrators to generate a report showing a comprehensive, end-to-end mapping of VMs to LUNs (see Figure 2). This report helps administrators avoid having to click through literally hundreds of screens to manually map the VMs-to-LUNs matrix. For example, in a medium-sized VMware environment of 100 VMs spread across 10 VMware ESX servers, only two screens would be required to fully map VMs to LUNs. This capability can not only help save a significant amount of time, but can also reduce the tendency to avoid change, helping increase the efficient use of resources.
- **Efficient capacity planning:** Determining how much storage has been committed to and is being used by individual VMs for a given LUN to ensure enough space is allocated typically requires time-consuming manual correlation between LUNs, ESX servers, and VMs. Virtualization-aware Navisphere Manager, however, allows administrators to simply search for a LUN by name to determine how much storage has been committed to and is being used by individual VMs for that LUN.

Navisphere Manager is available in all Dell/EMC CX4 Series storage arrays running the EMC FLARE® 29 operating environment, and is supported in VMware ESX 4, ESX 3.5, and ESXi hypervisors and VMware vCenter Server 2.5 and later.

ENHANCING STORAGE MANAGEMENT IN VIRTUALIZED INFRASTRUCTURES

Designed to bridge the management gap between virtual and physical environments, the virtualization-aware EMC Navisphere Manager application can simplify administration of VMware vCenter Server–managed storage. Navisphere Manager also helps enhance efficiency by providing end-to-end virtual-to-physical mapping of VMs to LUNs and vice versa in Dell/EMC CX4 Series storage arrays running the EMC FLARE 29 operating environment.

The ability to automatically map virtual-to-physical relationships and generate reports that detail this information helps reduce the amount of time required to perform storage management tasks such as problem diagnosis, change management, and capacity planning. Navisphere Manager is only one of several features available in Dell/EMC CX4 Series storage arrays designed specifically to offer the flexibility, manageability, and efficiency needed to fully take advantage of virtualization while meeting strict performance demands for large-scale enterprise applications.

Annette Cormier is a solutions marketing manager for Dell/EMC storage solutions. She has 20 years of experience in developing and bringing to market enterprise storage, network management, and security products for Dell, Hewlett-Packard, and SGI, and has previously been an IT SAS/Oracle database programmer at the Natural Resource Ecology Laboratory (NREL) at Colorado State and at Pacific Power and Light. Annette has a B.S. in Computer Science, Artificial Intelligence, from Colorado State University.

Andrew Gilman is a storage solutions marketing manager at Dell responsible for virtualization marketing activities. Andrew has a degree in Business Administration from the Boston University School of Management.

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OPTIMIZING DATA PROTECTION, SECURITY, AND COMPLIANCE FOR REMOTE AND BRANCH OFFICES

By Sanjeet Singh
Suresh Jasrasaria
George Sadler

Data protection can be challenging for remote or branch offices, particularly when sites are supported only by central IT resources or local IT staff dual-tasked with other functions. Combining Dell™ EqualLogic™ PS4000 series storage arrays and disk-based backup with the Dell PowerVault™ DL2100 – Powered by CommVault® helps simplify data protection through scalable storage solutions.

Exponential data growth within organizations today is escalating the cost and complexity of storage environments. Data centers and remote sites face growing storage sprawl and rising operating costs, and IT managers find it increasingly difficult to maintain a consistent approach to storage management and data protection. In addition, stringent regulations and budget constraints are pressing many organizations to rethink their IT strategies for remote or branch offices.

Organizations rarely find it cost-effective to maintain a full-time IT staff at remote offices. Instead, many remote or branch office sites rely on a part-time staff sourced from other internal business functions. Although this practice can help reduce costs, it can also lead to problems—for example, part-time staff members may lack sufficient training to manage a remote IT environment or the special skills required to manage advanced storage networks.

Despite the best efforts of remote IT staff, the result is often noncompliance with backup and data protection policies, placing data at risk of loss and running afoul of regulations such as the Sarbanes-Oxley Act (SOX), Data Protection Act (DPA), Health Insurance Portability and Accountability Act (HIPAA), and Fair Credit Reporting Act (FCRA). The alternative—leveraging a central IT staff to support remote teams—can lead to unbudgeted travel costs and unacceptable response times. Fortunately, advances in Internet bandwidth, virtualization, storage, and networking along with powerful, flexible Dell EqualLogic PS Series and Dell PowerVault storage systems provide opportunities to create innovative best practices for remote or branch office IT environments that help address these challenges.

DRIVING ENTERPRISE-LEVEL CAPABILITIES BEYOND THE CENTRAL DATA CENTER

Organizations can drive significant enterprise efficiencies by leveraging remote or branch office IT best practices such as the following:

- Consolidating direct attach server storage through Internet SCSI (iSCSI) storage area networks (SANs) at remote or branch offices
- Copying data to central or regional data centers for protection, retention, and analysis
- Using data deduplication and compression to help reduce bandwidth requirements
- Sizing storage capabilities to suit individual site requirements
- Virtualizing the infrastructure and implementing backup and recovery

- Consolidating regulated and critical data within centralized architectures protected by governed access control

The breadth of solutions offered by Dell and its partners—including hardware, software, and service offerings—can help organizations readily achieve these goals. Hardware solutions include Dell EqualLogic PS4000 series iSCSI SAN arrays and the Dell PowerVault DL2100 – Powered by CommVault. EqualLogic PS4000 arrays are designed to simplify management for both central and remote IT teams. Disk-based backup and recovery with the PowerVault DL2100, coupled with EqualLogic asynchronous auto-replication and integrated storage management software, enable a central IT staff to gain control over and visibility into backup environments across remote sites.

Software solutions such as the EqualLogic SAN HeadQuarters (SAN HQ) management suite together with the Dell Management Console Powered by Altiris™ from Symantec™ help simplify management. The suite provides built-in solutions for virtualization, data deduplication, and wide area network (WAN) optimization. In addition, Dell ProConsult Services, Dell ProManage™ Managed Services, and Dell ProSupport Services are available for designing, deploying, or managing remote IT operations and for recovering and recycling replaced hardware. IT managers can use these solutions to efficiently and cost-effectively meet the needs of their organizations.

SIMPLIFYING IT ENVIRONMENTS WITH A SCALABLE ARCHITECTURE

The Dell EqualLogic PS Series architecture is specifically designed to provide integrated storage for remote sites and departments, using advanced solutions that were previously limited to central or regional data centers because of cost constraints. For example, EqualLogic PS4000 iSCSI SAN arrays offer an entry point to the EqualLogic PS Series to help provide simplified administration, enterprise-class software, and a virtualized architecture. A cost-effective SAN designed for small remote or branch office environments, EqualLogic PS4000 arrays feature extensive integration with the larger EqualLogic PS6000 series arrays, providing scalability for growth. EqualLogic PS4000 and EqualLogic PS6000 arrays both support high-performance Serial Attached SCSI (SAS) drives and capacity-oriented Serial ATA (SATA) drives, with EqualLogic PS6000 arrays offering the additional option of high-performance solid-state drives (SSDs).

EqualLogic SAN HQ software is included with EqualLogic PS Series arrays at no additional cost. This management suite can provide consolidated performance and event monitoring across multiple virtualized EqualLogic SAN groups from multiple locations around the world.

The Dell PowerVault DL2100 – Powered by CommVault incorporates CommVault Simpana® software to provide a disk-based backup and recovery solution that allows organizations to quickly begin protecting critical data. The PowerVault DL2100 is a full-featured backup appliance where the backup storage is automatically managed by CommVault Simpana software, helping remove the need for storage administration tasks. With integrated CommVault deduplication capabilities, the PowerVault DL2100 is designed to minimize the bandwidth required to send remote backup data sets to centralized, consolidated backup servers and significantly reduce storage requirements. Combining the asynchronous auto-replication features of the EqualLogic PS Series with the deduplication and disk-to-disk-to-tape backup functionality of the PowerVault DL2100 can enable organizations to create an advanced, highly scalable storage solution.

Deploying EqualLogic PS6000 series arrays at central or regional data centers along with EqualLogic PS4000 arrays at remote offices helps simplify storage consolidation. IT managers can connect these arrays between remote sites and a central site for cost-effective data protection leveraging asynchronous auto-replication. In a small branch office where recovery time objectives (RTOs) can be met more easily because of low data change rates compared with central sites, data can be replicated over IP to the central site for centralized disaster recovery using the replication technology included in all EqualLogic PS Series arrays. When local disaster recovery is necessary to help accelerate response times or when data change rates are high, organizations can deploy a PowerVault DL2100 at the remote site to provide that capability. In fact, the PowerVault DL2100 can be used in dual roles—supporting both local backup and disk and tape storage at a central site. If WAN bandwidth constraints are a consideration, the deduplication capability in the PowerVault DL2100 provides an alternative to costly compression technology.

BUILDING AN EFFECTIVE APPROACH FOR ORGANIZATIONAL GROWTH

As organizations grow, they may acquire multiple remote sites of varying sizes and with varying functions. Examples include banking organizations opening new branches, manufacturers adding subsidiaries, and organizations acquiring other entities that become part of their infrastructure.

"The Dell EqualLogic PS Series architecture is specifically designed to provide integrated storage for remote sites and departments."

Large organizations require an infrastructure that can span multiple remote sites and a central data center. If they are not already consolidating their storage and data protection in a central location, they may consider doing so by deploying Dell storage. The amount of data, the data change rate, and the bandwidth available at a particular site dictate the appropriate solution. The principal challenge for large organizations is that no single solution can necessarily fit every site.

To meet this challenge, organizations can use a variety of integrated Dell solutions for different remote sites. For example, an organization headquartered in New York City with offices of different sizes in London, New Delhi, and Tokyo could meet its remote or branch office requirements with a scalable architecture of integrated Dell solutions (see Figure 1). Consider what happens when this New York–based organization first opens its London location. This site can initially use a single EqualLogic PS4000 SAN, which replicates its data to an EqualLogic PS6000 SAN at the New York headquarters. As business at the London site grows, the organization adds a local EqualLogic PS6000 array to increase storage capacity and accommodate the increased data volume. The EqualLogic PS4000 array integrates with the EqualLogic PS6000 array, and the site can continue adding arrays as it grows—there is no need for the organization to throw out what it already has deployed.

Eventually, the organization may designate the London site as a regional disaster recovery site to help protect data in case the New York data center goes down, with comprehensive replication of data at that central site. The arrays replicate across the WAN using compression and need to send only changed data sets through the EqualLogic PS Series auto-replication functionality, rather than the complete data set.

When the organization acquires a second site located in New Delhi, IT management may determine that this site has a relatively small data volume and a low data change rate. Therefore, a single EqualLogic PS4000 array at this location can handle the needs of that remote environment, and can integrate directly with the EqualLogic PS6000 SAN at the central New York site while using built-in replication functionality to back up to the central site. Because RTOs can be met more easily than at the other sites and the built-in EqualLogic replication functionality can handle the change rate without overtaxing the WAN, management may decide not to deploy disk-based backup with a PowerVault DL2100 at this location.

Later, when the organization acquires a subsidiary in Tokyo, this site is identified as having a high change rate, where the WAN may become a constraint for backing up data to the central New York site. To help solve the problem without the need to invest in a compression solution, the organization can take advantage of the built-in data deduplication in the PowerVault DL2100. Data deduplication helps reduce the amount of data that must be pushed over the WAN for consolidated storage and data protection at the central site. The PowerVault DL2100 also provides local backup at the Tokyo site, which requires fast response because it is a regional office providing customer service throughout Asia. The PowerVault DL2100 integrates well with the EqualLogic SAN at the Tokyo site and can handle disk-based backup for multiple EqualLogic PS4000 and EqualLogic PS6000 arrays as the site grows.

Data from all three remote sites can be sent back to the New York headquarters and managed there. As a result, the organization needs full-time storage personnel

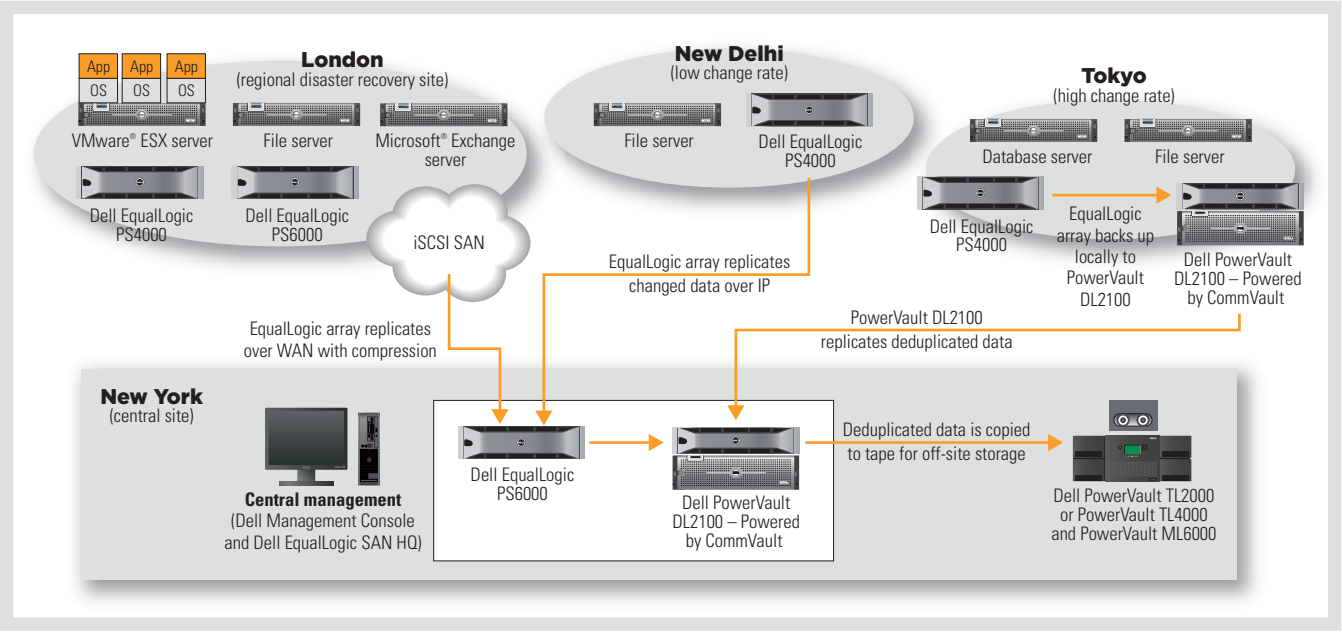

Figure 1. *Dell storage–based infrastructure for a large organization with varying remote and branch offices*

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only in New York. Disk-based backup with a PowerVault DL2100 at the central site sends deduplicated data to tape for off-site storage. The EqualLogic SANs are also designed to fit well within virtualized environments, if the organization elects to optimize their infrastructure with virtualization in the future.

The Dell Management Console can provide a single view of the entire IT environment, including deployment, inventory, monitoring, and updating the infrastructure. Storage administrators can also launch the EqualLogic SAN HQ tool from within the Dell Management Console. EqualLogic SAN HQ provides consolidated performance and event monitoring and visibility into the efficient use of EqualLogic PS Series SANs across the organization, allowing the IT staff to manage the storage architecture from the central site and offload management requirements from the part-time personnel in the field (see Figure 2). In the example scenario, the central IT team in New York could use EqualLogic SAN HQ for consolidated views of alerts, I/Os per second (IOPS), capacity, latency, and network activity.

OPTIMIZING DATA PROTECTION

For remote or branch offices and departments within large enterprises, the combination of Dell EqualLogic PS4000 iSCSI SAN arrays and disk-based backup and recovery with the Dell PowerVault DL2100 – Powered by CommVault can offer an effective solution for optimized data protection, regulatory compliance, consolidation, and security. Disk-based backup with the PowerVault DL2100 integrates CommVault Simpana software to provide local backup and built-in deduplication to help economically send data over a WAN to a central data center. The backup data can then be managed at the central location using the PowerVault DL2100 device's integrated CommVault console. The EqualLogic SAN HQ software included with EqualLogic SANs offers event monitoring and visibility into the efficient use of EqualLogic PS Series storage across the organization.

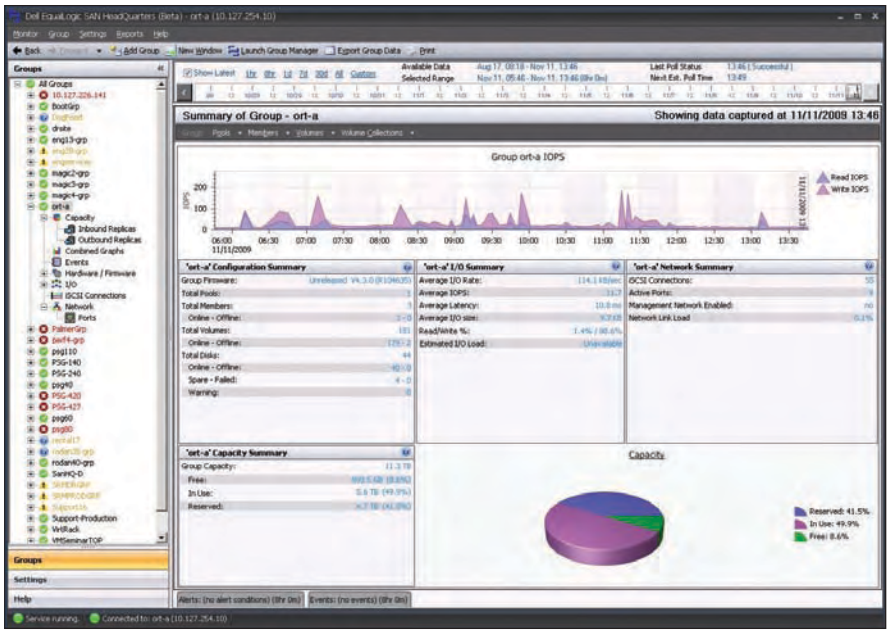

Figure 2. *Performance and event monitoring in Dell EqualLogic SAN HQ*

A combination of easy-to-use, automated storage at remote sites and the visibility to manage the entire architecture from a central site helps take the burden off part-time IT staff members at remote or branch offices, who are frequently dual-tasked with other functions. Implementing best practices at remote or branch office sites using Dell and partner solutions can help cost-effectively ensure data protection, regulatory compliance, and security at these sites even as the organization grows.

Sanjeet Singh is a global product marketing manager in the Dell Enterprise Storage Group with eight years of experience in developing and delivering business-critical technologies, including databases and data protection. He has an M.S. in Computer Engineering from Purdue University and an M.B.A. from the University of Texas.

Suresh Jasrasaria is a product marketing senior consultant in the Dell Enterprise Storage Product Group. Before joining Dell, Suresh worked in the data storage industry for more than 20 years at organizations such as EMC, Veritas, and Digital Equipment Corporation. He has a bachelor's degree in Electrical Engineering from the Indian Institute of Technology Kanpur, a master's degree in Computer Science from the University of Toronto, and an M.B.A. from Boston College.

George Sadler is a vertical solutions marketing strategist for the Dell Enterprise Solutions Marketing team with more than 20 years of experience spanning national defense, law enforcement, manufacturing, legal markets, and technology industries. He has an undergraduate degree from the University of California, Los Angeles, and an M.B.A. from the University of Texas at Austin.

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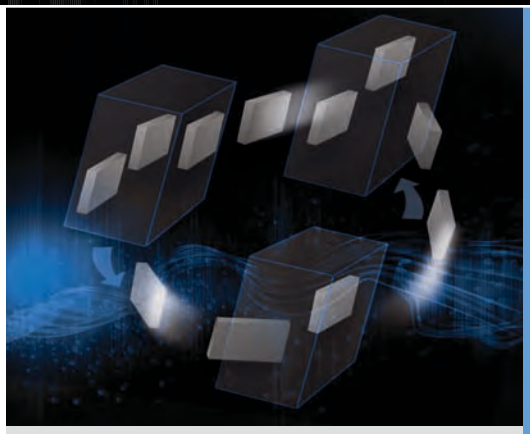
MEETING BACKUP AND RECOVERY CHALLENGES IN PHYSICAL AND VIRTUAL ENVIRONMENTS



By Marc Mombourquette

Traditional approaches to backup and recovery can quickly become expensive and difficult to manage in virtualized environments—especially as those environments grow over time. Acronis Backup & Recovery® 10 software together with Dell™ storage can help organizations address the recovery time, scalability, cost, and performance challenges of data protection in these environments.

Virtualization can offer major advantages for consolidation and business continuity in enterprise IT environments. As part of the planning process for virtualization, IT administrators have an opportunity to evaluate and update their strategies for securing and restoring data. Although it is clear that each virtual machine (VM) must have some sort of backup and recovery protection, traditional techniques for protecting physical servers may not work well for protecting VMs—quickly becoming expensive and difficult to manage as the environment grows. Key elements to consider as part of an evaluation include recovery time objectives (RTOs), scalability, cost, and performance.

Acronis Backup & Recovery 10 software is designed specifically to address these challenges. This comprehensive, high-performance data protection and disaster recovery solution can help protect physical servers and workstations running Microsoft® Windows® or Linux® operating systems as well as VMs based on Microsoft Hyper-V™, VMware®, Citrix® XenServer™, and Parallels virtualization platforms from a single centralized management console designed for ease of use.[1] Together with Dell storage arrays, it can provide a simple, scalable, and cost-effective way to meet enterprise RTOs while helping protect critical systems.

RECOGNIZING THE LIMITATIONS OF TRADITIONAL BACKUP

Using traditional backup approaches in virtualized environments—generally by placing software backup agents on each VM—can work well with small implementations, but can be costly in the long run. As VM count within an IT environment increases, the number of agents increases as well. As environments grow to potentially include thousands of VMs, the growth in licensing costs alone can become unsustainable.

Another challenge to consider is the ability to meet RTOs—the maximum time allowed to recover a system after a failure. There are two main hurdles to clear when meeting an RTO goal: recovering the OS and application to a consistent running state, and recovering the required data back into the system. The traditional method of recovering a system typically requires IT staff to reinstall the OS and the backup application before they can recover the data, after which they must apply patches and configure the backup application to work with the backup infrastructure. The entire process can require significant expertise and potentially take hours to complete, even before the first byte of data is restored.

In addition, although many organizations are implementing server virtualization to help gain efficiencies from their server hardware, the reality is

[1] For more information on comprehensive Acronis support for major virtualization platforms, see "The Hidden Costs of Virtualization," by Acronis, Inc., October 2009, available at www.acronis.com/promo/dell2009.

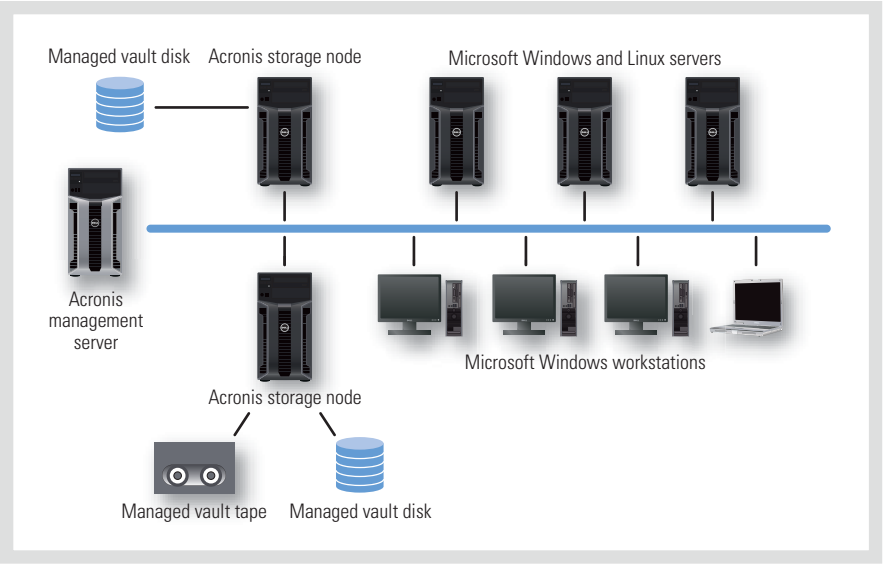


Figure 1. *Acronis Backup & Recovery 10 architecture*

that placing 15–20 VMs on a single physical server typically leads to significantly increased demands on processor, memory, and I/O processing. Because backup processes are often highly resource intensive, they can slow significantly as VMs proliferate and consume an increasing amount of physical resources.

MEETING RECOVERY TIME OBJECTIVES

The integrated system recovery capabilities in Acronis Backup & Recovery 10 enable IT staff to rapidly recover systems and applications to a consistent state. The patented Acronis disk-imaging and bare-metal restore technology is designed to allow comprehensive system recovery back to the state at which the backup was performed, without the need to reinstall and reconfigure the backup application.

Acronis Backup & Recovery 10 also helps standardize the recovery process into easy-to-follow procedures, helping free highly skilled IT personnel to focus on other tasks. In a major disaster, IT staff can perform a concurrent mass recovery with a high level of automation, helping avoid the manual, time-consuming, and error-prone processes that might otherwise be required.

Recovery can be accomplished quickly even using dissimilar systems. Recovering a system onto dissimilar hardware often means the system cannot start normally, potentially requiring hours or even days of work from skilled engineers to perform tasks such as copying and replacing drivers and editing and creating Windows registry keys. The Acronis Backup & Recovery 10 Universal Restore option helps dramatically simplify and streamline this process, enabling organizations to use dissimilar hardware for standby purposes and helping eliminate the need to provision identical hardware for recovery or deploy potentially expensive clustering solutions. IT staff can add drivers for the new hardware to a recovery CD before or during the recovery process, and the Universal Restore option can automatically configure the underlying OS settings to help ensure the recovered system runs on the new hardware.

ENHANCING SCALABILITY AND CONTROLLING COSTS

When deploying Acronis Backup & Recovery 10, organizations can invest in infrastructure only as it is needed. The software is based on a scalable architecture designed to grow from protecting a single workstation in a home office to potentially thousands of workstations and servers in a large enterprise (see Figure 1). A single Acronis Backup & Recovery 10 domain can scale up to 20 storage nodes, with each node managing up to 20 disk or tape vaults, all of which can be controlled through a single management server. Administrators can add resources such as disk capacity and backup servers on demand to handle new workloads, helping minimize startup costs.

The agentless approach used by Acronis Backup & Recovery 10 also helps avoid rising agent costs as VM count increases. Acronis offers a license model that supports virtualized environments with fixed pricing based on the number of physical servers rather than the number of VMs—enabling administrators to add VMs to existing servers and protect those VMs without incurring additional licensing costs.

In addition, the integrated Acronis Backup & Recovery 10 Deduplication option can help further lower costs by helping to dramatically reduce overall storage requirements and simplify remote office backup. Source-level deduplication for the remote systems enables backups to run over a wide area network using minimal bandwidth, which helps eliminate the need to purchase, deploy, and maintain disk or tape storage devices at the remote location. In fact, these savings may be significant enough to enable organizations to cost-effectively extend deduplication to workstations and laptops.[2]

Organizations performing remote office and workstation or laptop backups can also gain the advantages of remote recovery, helping avoid the time and cost of sending IT staff to distant locations for desk-side service. Instead, administrators can recover multiple systems at different locations simultaneously from a single console.

[2] For more information on Acronis deduplication, see "How Deduplication Benefits Companies of All Sizes," by Acronis, Inc., June 2009, available by sending an e-mail request to marketing@acronis.com.

CENTRALIZING MANAGEMENT

Managing data backup for a large environment can be tedious when hundreds or thousands of systems are involved. Acronis Backup & Recovery 10 enables administrators to centrally manage backup policies, servers, storage nodes, and vaults through a single centralized console designed for ease of use. Policy-based management helps eliminate the need to create backup jobs on each individual system; instead, administrators can create a standard policy and apply it to a group of systems, helping to save time and avoid backup jobs that deviate from existing backup policies.

All managed systems in the backup infrastructure—both physical and virtual—are registered to the Acronis Backup & Recovery management server and listed in the console. Administrators can create groups to organize managed systems, and can assign systems to more than one group to help maximize flexibility. Administrators can also drill down into backup image sets and initiate tasks such as consolidation, validation, expiration, and cleanup. Advanced scheduling features and templates also help increase flexibility, enabling administrators to design the backup rotations and schemas appropriate to their requirements. As the environment grows, the efficiencies afforded by this centralized management can grow along with it.

MAINTAINING HIGH PERFORMANCE

To help ensure high-performance backups, Acronis Backup & Recovery 10 is designed to capture entire disk images and save them to disk storage such as a storage area network (SAN), network attached storage (NAS), direct attach storage (DAS), RAID arrays, or rewritable optical disks. Storage devices such as tape drives and libraries are also supported.

Utilizing the Acronis Backup & Recovery 10 Deduplication option can also help dramatically reduce storage requirements and demands on processor resources, I/O capacity, and network bandwidth to make highly efficient use of available resources. Administrators can choose between deduplication at source and target to help reduce storage volumes. When deduplication at source is selected, the backup client performs the deduplication process before transmitting the data to the storage node, helping reduce bandwidth requirements. When deduplication at target (storage) is selected, the backup client transmits the backup data to the storage node, with the storage node then performing the deduplication, helping to significantly reduce storage volumes to optimize storage capacity.

SIMPLIFYING DATA PROTECTION IN VIRTUALIZED ENVIRONMENTS

Organizations planning for virtualization should evaluate their strategies for securing and storing data and implement a storage and backup system that can help them meet RTOs and control costs while providing the scalability and performance to meet their needs. Acronis Backup & Recovery 10 is designed to address these challenges for organizations of all sizes, including a choice of seven editions to suit a variety of sizes and needs. By offering simple, cost-effective backup and recovery for both physical systems and VMs, Acronis Backup & Recovery 10 and Dell storage can help organizations create a robust, efficient infrastructure that can scale on demand as the IT environment grows.

Marc Mombourquette is a product marketing manager at Acronis. His interests include backup and recovery, virtualization, and emerging technologies. Marc is a graduate of the University of Massachusetts Amherst.

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DESIGNING RESEARCH COMPUTING SOLUTIONS FOR THE CERN/ATLAS PROGRAM

By Jacob Liberman
Walker Stemple

The ATLAS experiment at the European Organization for Nuclear Research (CERN) Large Hadron Collider represents a major effort to uncover the elementary building blocks of matter and energy. This article describes extensive optimization tests and best-practice recommendations for configuring 11th-generation Dell™ PowerEdge™ servers to help process the enormous amount of data expected from this experiment.

The European Organization for Nuclear Research (CERN) hosts the Large Hadron Collider (LHC)—the world's largest particle collider—on the border between France and Switzerland near Geneva. The ATLAS experiment is the largest of six LHC experiments utilizing proton-proton collisions to uncover the elementary building blocks of matter and energy. Hadrons, or protons, are accelerated to close to the speed of light by superconducting magnets and then carefully steered into an identical oncoming beam within the ATLAS detector. Researchers hope to discover new particles hypothesized to exist, like the Higgs boson, to help complete the standard model of particle physics.

This pure science experiment creates unprecedented challenges in data storage and computing. With a full trigger data rate of 780 MB/sec, ATLAS is expected to generate up to 15 PB of raw detector data per year. The research institutions responsible for organizing and examining the data are organized into a three-tiered worldwide computing grid known as the Worldwide LHC Computing Grid (WLCG). The tier-0 CERN analysis facility selects only the most interesting events at a rate of 320 MB/sec. This data is sent for redundant storage and processing at 10 tier-1 facilities worldwide. The server computational requirement for the processing of this data is estimated to be 1.7 million SI2K, where SI2K is the Standard Performance Evaluation Council (SPEC) SPECint2000 score from the CPU2000 benchmark—which amounts to the computational capability of thousands of servers.

This prestigious scientific endeavor is supported by thousands of scientists at more than 200 institutions and universities in close to 60 countries worldwide. Dell is committed to helping these researchers meet their ATLAS computing challenges by providing advanced computational, interconnect, and storage technologies through key partnerships with industry leaders. A specialized Dell team of industry experts is dedicated to working with researchers and industry partners to advance the goals of the ATLAS experiment. This article describes the collaboration between Dell and CERN researchers to design computing solutions that can process the enormous amount of data generated by the LHC. It includes results from extensive performance optimization tests and shares best-practice recommendations for configuring 11th-generation Dell PowerEdge servers for use as part of the ATLAS experiment.

HEP-SPEC BENCHMARK TESTS

ATLAS researchers developed the High-Energy Physics (HEP)–SPEC benchmark suite to standardize server performance evaluation for their experiments. HEP-SPEC is based on the standard SPEC CPU2006 benchmarking suite. CPU2006 is widely used to rate

processor performance for two reasons. First, because it comprises real application benchmarks, CPU2006 results can accurately reflect performance across a broad range of server workloads. Second, the benchmark run rules allow vendors to implement BIOS and compiler optimizations that showcase their systems' peak performance.

HEP-SPEC uses the all_cpp subset of CPU2006 with specific compiler versions and optimization flags. Because HEP-SPEC performance correlates strongly with ATLAS application performance, it can provide a consistent and repeatable benchmark to describe experiment requirements and existing resources. The all_cpp subset was selected over the base benchmark because it matches the scaling behavior and floating-point-to-integer ratio of the production physics codes. Furthermore, HEP-SPEC is typically compiled in 32-bit mode using the open source GNU Compiler Collection (GCC), helping ensure backward compatibility with sites that lack 64-bit resources or commercial compilers.

In May 2009, the Dell HPC engineering team studied HEP-SPEC performance in support of the Dell CERN/ATLAS program. This study had two goals. The first goal was to understand how server subsystem performance—such as processor capabilities or memory bandwidth—affects HEP-SPEC performance, to help the Dell team make informed recommendations on how CERN/ATLAS researchers can maximize their research investment. The second goal was to understand how the BIOS features in 11th-generation Dell PowerEdge servers affect HEP-SPEC performance. These servers introduced multiple BIOS features designed to boost performance and energy efficiency, and understanding how these features affect HEP-SPEC performance helps the Dell team recommend optimal BIOS settings that can accelerate research and decrease time to solution.

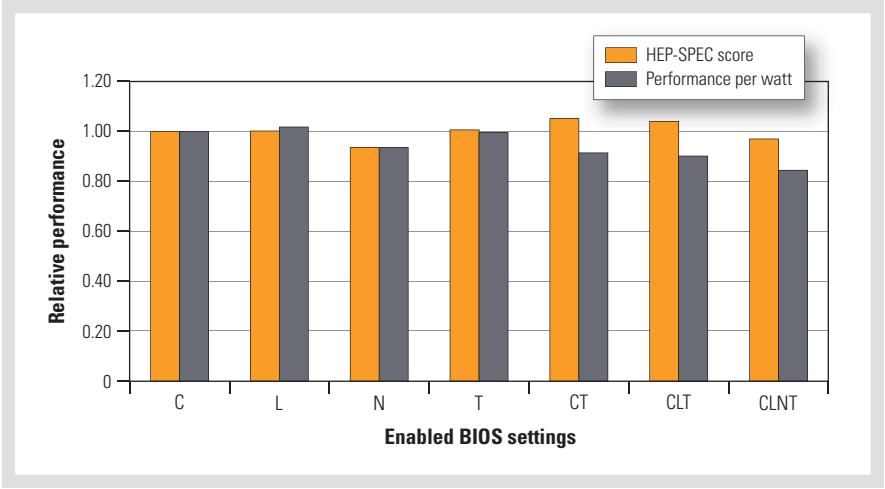

Figure 1. *HEP-SPEC performance and efficiency relative to a system with all BIOS settings disabled*

TEST RESULTS: PERFORMANCE AND ENERGY EFFICIENCY

The 11th-generation Dell PowerEdge server family is based on the Intel® Xeon® processor 5500 series microarchitecture, and introduced architectural enhancements and BIOS features designed to increase performance and enhance energy efficiency. The Dell HPC engineering team evaluated the impact of the following BIOS settings on HEP-SPEC performance in 11th-generation PowerEdge servers in a variety of configurations:

- **C-states:** Allows the system BIOS to throttle power to individual processor cores based on need, which can enhance energy efficiency
- **Logical processor (formerly called Intel Hyper-Threading Technology):** Improves thread-level parallelism by sharing the same physical core between multiple threads, which can increase performance for some codes
- **Node interleaving:** Creates uniform memory access speed by interleaving memory across both processor sockets, which can help increase performance for codes that require a large global memory address space
- **Turbo mode:** Increases processor clock rate by 1–3 increments of 133 MHz if there is available system power and heat headroom
- **Power management profile:** Allows the OS or system BIOS to control power to the processor sockets, memory, and fans, which can help increase performance or improve energy efficiency; all servers in this study used the Max Performance profile[1]

Figure 1 shows the normalized HEP-SPEC performance and performance per watt of different combinations of BIOS settings in a PowerEdge R610 server relative to the same server with all settings disabled; "C" represents the C-states setting, "L" represents the logical processor setting, "N" represents the node interleaving setting, and "T" represents the turbo mode setting. Performance per watt was calculated by dividing HEP-SPEC performance by average power consumed (in watts) during the run. A higher score is better for both measures.

As these results show, enabling both the C-states and turbo mode settings increased HEP-SPEC performance by 5 percent compared with having all settings disabled; enabling these settings individually, however, did not increase performance. The combination of the C-states and turbo mode settings also reduced energy efficiency by approximately 10 percent—meaning that the performance gain is outweighed by a

[1] For more information on these settings and how they can affect HPC performance, see "Optimal BIOS Settings for High Performance Computing with PowerEdge 11G Servers," by Jacob Liberman and Garima Kochhar, Dell Product Group, July 2009, i.dell.com/sites/content/business/solutions/whitepapers/en/documents/HPC_Dell_11G_BIOS_Options.pdf.

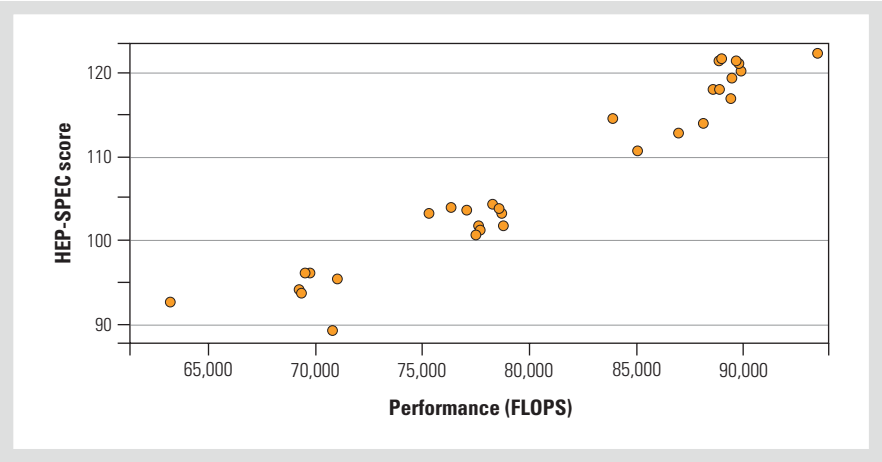

Figure 2. *Plotted relationship between FLOPS and HEP-SPEC score*

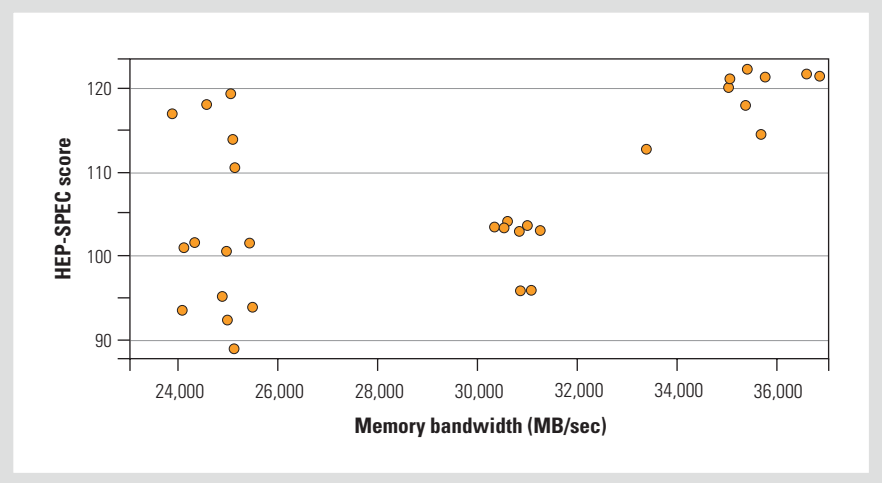

Figure 3. *Plotted relationship between memory bandwidth and HEP-SPEC score*

proportionate increase in power consumption. The other tested settings had no impact on HEP-SPEC performance except for node interleaving, which reduced performance even when the C-states and turbo mode settings were also enabled. Enabling the logical processor setting can help increase HEP-SPEC results when running 16 threads, but HEP-SPEC run rules often stipulate that this setting be disabled because it has traditionally not been used with CERN/ATLAS production codes.

After having identified the optimal BIOS settings, the Dell team next focused on identifying system components that could help maximize performance and energy efficiency. CERN/ATLAS research computing resources fall into two categories: those that are dedicated exclusively to processing ATLAS data, and those that conduct general-purpose research computing in addition to ATLAS data processing. During this second phase of the study, the Dell team evaluated HEP-SPEC performance across approximately 70 processor and memory combinations.

The results reveal several important facts about HEP-SPEC. First, HEP-SPEC is a processor-bound workload, meaning that faster processors translate into faster time to results. Figure 2 shows the strong correlation between floating-point operations per second (FLOPS)—a measure of the rate at which processors can solve floating-point calculations—and HEP-SPEC performance in the tested servers, which increases almost linearly with processor capability. In fact, the statistical correlation between these two metrics is 97 percent, meaning that the HEP-SPEC result can be predicted with 97 percent accuracy based on the measured FLOPS result alone. Figure 3, in contrast, plots the relationship between memory bandwidth and HEP-SPEC performance. The statistical correlation between these two metrics is much weaker than the correlation shown in Figure 2, indicating that increased memory performance does not translate directly into an increased HEP-SPEC score. Memory bandwidth and floating-point performance were measured with the STREAM and Double Precision General Matrix Multiply (DGEMM) benchmarks, respectively.

Several important design recommendations can be drawn from these measurements. First, for dedicated HEP-SPEC computing resources, faster processors accelerate data processing more than faster memory. The 11th-generation PowerEdge server family supports dual in-line memory modules (DIMMs) at speeds of 1,066 MHz and 1,333 MHz. The HEP-SPEC performance difference between DIMM speeds is less than 3 percent; therefore, if the cost difference between DIMM speeds is greater than 3 percent, ATLAS researchers generally would benefit more from upgrading their processors than from buying faster DIMMs.

Figure 4 shows the normalized HEP-SPEC performance of a PowerEdge R610 server with different registered DIMM (RDIMM) and unbuffered DIMM (UDIMM) configurations relative to the same server with six 4 GB UDIMMs at 1,066 MHz. The performance differences between DIMM types, speeds, and count per channel are within 3 percent; however, the power consumption differs by up to 12 percent. Therefore, the baseline configuration of six 4 GB UDIMMs at 1,066 MHz can provide an optimal fit for HEP-SPEC in terms of performance and energy efficiency.

DESIGN RECOMMENDATIONS

Based on the results of this study, the Dell HPC engineering team recommends

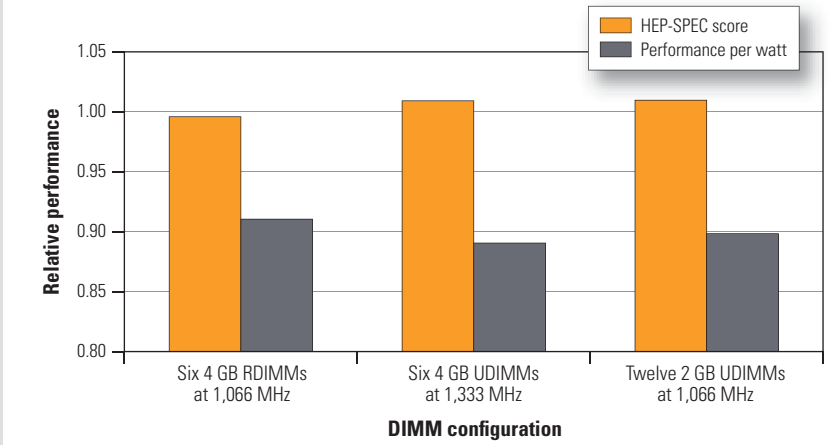

Figure 4. *HEP-SPEC performance and efficiency relative to a system with six 4 GB UDIMMs at 1,066 MHz*

enabling the C-states and turbo mode BIOS settings, disabling the logical processor and node interleaving settings, and using the Max Performance power management profile to help maximize HEP-SPEC performance on 11th-generation Dell PowerEdge servers. These optimized BIOS settings can be configured at the factory before servers are shipped to CERN sites.

Although enabling the logical processor setting did not increase HEP-SPEC performance in these tests, CERN/ATLAS researchers have found that enabling this setting does help increase the performance of their production codes. Therefore, the Dell HPC engineering team also recommends testing whether this feature increases the performance of specific production codes.

The Dell CERN/ATLAS team has also developed several reference architectures based on the results of this study. These configurations are designed to provide optimal configurations to help meet a variety of goals, including energy efficiency, performance, and cost value (see Figure 5). The balanced configuration is designed to be competitive in each of those three categories, while the general-purpose configuration is well suited for general-purpose cluster computing as well as ATLAS data processing.

It is important to keep in mind that HEP-SPEC is not a traditional clustered HPC application, and does not require communication or data coherency across cluster nodes. For this reason, clusters designed to maximize HEP-SPEC throughput may not be ideally suited for clustered HPC applications. Purchasing decisions for general-purpose clusters should not be based solely on HEP-SPEC results; these results should be supplemented with standard cluster benchmarks such as SPEC MPI or HPC Challenge.

From a design standpoint, general-purpose clusters can likely benefit from a low-latency interconnect such as 10 Gigabit Ethernet or InfiniBand, and most clustered HPC applications can also benefit from increased memory bandwidth. Therefore, when designing a general-purpose cluster that occasionally processes HEP-SPEC data, a balanced memory configuration and increased DIMM speeds could help increase performance.

	Server model	Processor model	DIMM configuration
Energy efficiency	Dell PowerEdge M610	Intel Xeon L5520	Four 4 GB UDIMMs at 1,066 MHz
Performance	Dell PowerEdge R610	Intel Xeon X5570	Six 4 GB RDIMMs at 1,333 MHz
Balanced	Dell PowerEdge R410	Intel Xeon E5540	Six 4 GB UDIMMs at 1,066 MHz
Value	Dell PowerEdge R410	Intel Xeon E5520	Four 4 GB UDIMMs at 1,066 MHz
General-purpose	Dell PowerEdge M610	Intel Xeon X5550	Six 4 GB UDIMMs at 1,066 MHz

Figure 5. *Recommended CERN/ATLAS reference configurations to help meet different goals*

DELL AND ATLAS

ATLAS institutions that are currently utilizing 10th-generation Dell PowerEdge servers with the Intel Xeon processor 5400 series can expect a significant boost in HEP-SPEC performance when switching to 11th-generation PowerEdge servers with the Intel Xeon processor 5500 series. Dell continues to monitor emerging technologies for applicability to high-energy physics experiments like ATLAS. Anticipated directions for future study include evaluating the performance and energy efficiency of production ATLAS codes on 11th-generation PowerEdge servers.

Jacob Liberman is a development engineer in the Scalable Systems Group at Dell.

Walker Stemple is a business development manager on the CERN/ATLAS team at Dell.

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DEPLOYING MICROSOFT WINDOWS HPC SERVER 2008 WITH INFINIBAND

By Aziz Gulbeden
Munira Hussain

InfiniBand can provide a high-speed, low-latency interconnect for high-performance computing (HPC) clusters running the Microsoft® Windows® HPC Server 2008 solution. This article outlines how Windows HPC Server 2008 facilitates InfiniBand integration and describes benchmark tests showing the performance increases possible when using InfiniBand as the cluster network fabric.

As the demand for high-speed, low-latency networks rises, InfiniBand has become increasingly popular as an interconnect in high-performance computing (HPC) clusters. Microsoft Windows HPC Server 2008 supports InfiniBand as a Remote Direct Memory Access (RDMA) network, which can enable cluster applications to take full advantage of the interconnect capabilities, while the tools provided in HPC Cluster Manager help simplify InfiniBand integration. This article outlines how administrators can configure InfiniBand as a high-speed, low-latency interconnect in Windows HPC Server 2008 and describes benchmark test results illustrating the performance increases possible when using Quad Data Rate (QDR) InfiniBand in Windows HPC Server 2008–based clusters.

CONFIGURING THE INFINIBAND INTERCONNECT

Microsoft Windows HPC Server 2008 includes Network Direct, a low-latency RDMA interface that enables bypassing the OS network stack for Message Passing Interface (MPI) network traffic. Network Direct is available for interconnects such as InfiniBand that provide RDMA functionality. Bypassing layers in the OS network stack enables Network Direct to help improve both bandwidth and latency compared with other network packages that must use the regular TCP/IP stack.

Driver installation

Based on the open source Windows OpenFabrics (WinOF) stack from the OpenFabrics Alliance, the Mellanox WinOF 2.0.5 distribution used in this article includes drivers and management applications for HPC clusters.[1] The InfiniBand drivers are packaged as a Microsoft Windows Installer (MSI) file that administrators can install using the graphical setup interface packaged with the drivers. After the drivers have been installed, the ports on the InfiniBand host channel adapter (HCA) appear as a connection in the Control Panel under "Network Connections," with the devices named "Mellanox IPoIB Adapter" followed by a port number. By default, the IP information for the connection is obtained through Dynamic Host Configuration Protocol (DHCP). When using the WinOF driver installation wizard to install the InfiniBand drivers, Network Direct can be enabled by selecting the check box in the dialog that appears after the installation.

Administrators can also use the command line for driver installation. The command `msiexec /qn /i path`, where *path* is the path to the WinOF MSI package, enables driver installation through the command

[1] For more information, visit www.openfabrics.org and www.mellanox.com.

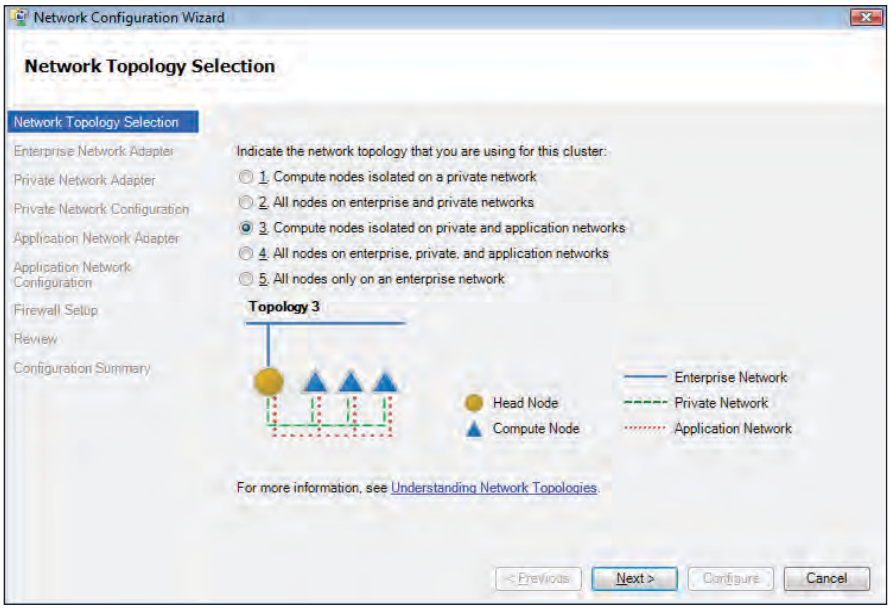

Figure 1. *Cluster network topology options in the Network Configuration Wizard*

line; the MSI package can reside on a network share to help avoid the need to copy packages to individual cluster nodes. The `clusrun` command enables running the same command on multiple compute nodes in parallel, which can help save a significant amount of time for driver installation in large clusters. The `ndinstall` command, which comes with the InfiniBand driver, can be used with the `-i` parameter to enable Network Direct after driver installation. When Network Direct is enabled, the `ndinstall -l` command lists the OpenIB Network Direct provider.

HPC Cluster Manager provides compute node templates that contain the steps to be executed during node deployment. Administrators can add `msiexec` and `ndinstall` commands to the template to install InfiniBand drivers and enable Network Direct automatically during node deployment.

Network configuration

By default, the InfiniBand ports obtain the network address through DHCP. For the links to become active, a subnet manager must be running on the network. If the subnet manager is present and enabled on the InfiniBand switch, the links then become active. Otherwise, administrators can start the OpenSM service on the cluster head node or on one of the compute nodes by going to the Services window on the desired node under Start > Administrative Tools > Services, and then starting the OpenSM service.

After the InfiniBand ports are active, administrators can set up the DHCP server using the Network Configuration Wizard in HPC Cluster Manager. Before configuring the DHCP server, best practices recommend restarting the HPC Management service in the Services list on the head node so that all ports can be correctly identified by the wizard.

The main configuration step to enable use of RDMA over InfiniBand for MPI protocol traffic is configuring the network topology in HPC Cluster Manager. The topology where the compute nodes are isolated on private and application networks (topology 3 in the Network Configuration Wizard, as shown in Figure 1) was used in this article. The InfiniBand network is selected as the application network. After the wizard finishes performing the configuration, the MPI packages automatically begin using RDMA over the InfiniBand network and can immediately gain the advantages offered by the InfiniBand interconnect.

Administrators can verify that the DHCP server is set up correctly by selecting Start > Administrative Tools > DHCP. In the IPv4 section of the DHCP Properties window, the InfiniBand subnet should appear with address leases coming up as compute nodes request IP addresses for their InfiniBand interfaces. The DHCP server must be authorized and bound to the private and application networks, both of which can be verified by right-clicking on the server name in the DHCP window. If the InfiniBand network does not appear in the DHCP Properties window, it may be necessary to restart the DHCP service using the Services window.

HPC Cluster Manager contains several diagnostic tools to help administrators quickly verify the network stack

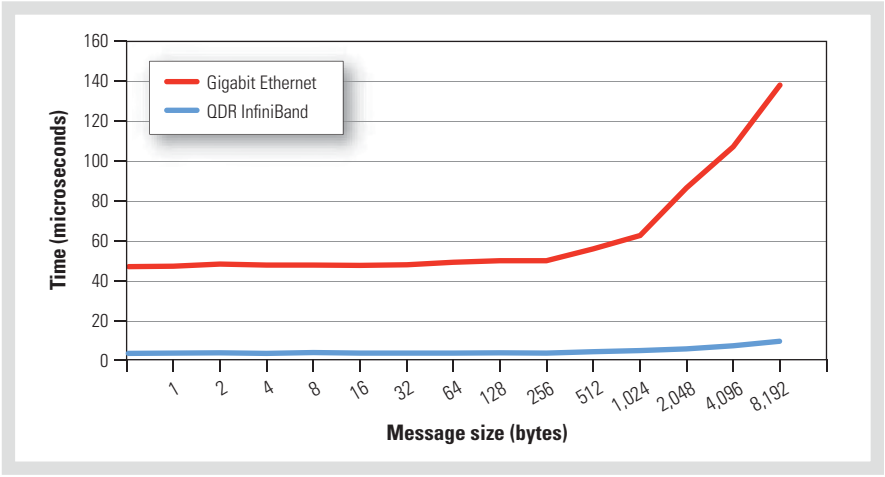

Figure 2. *Latency results from the Intel MPI Benchmarks PingPong test*

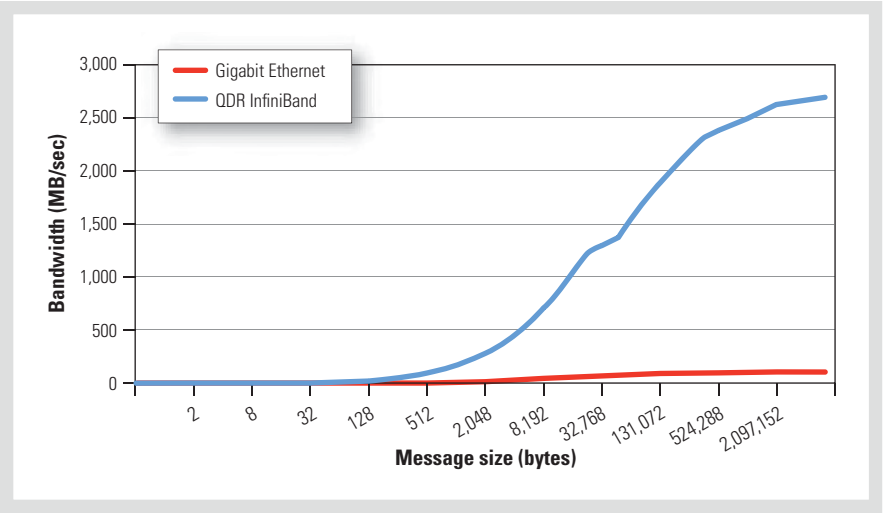

Figure 3. *Bandwidth results from the Intel MPI Benchmarks PingPong test*

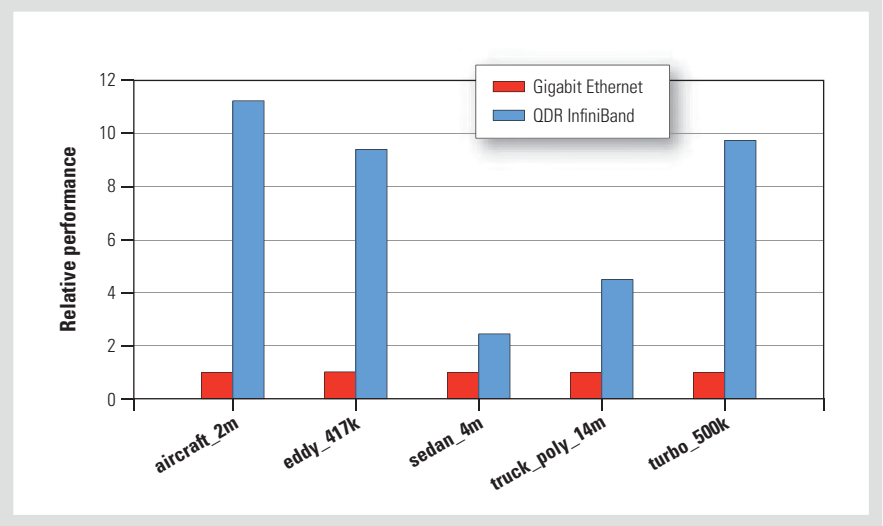

Figure 4. *Relative performance across multiple ANSYS FLUENT tests*

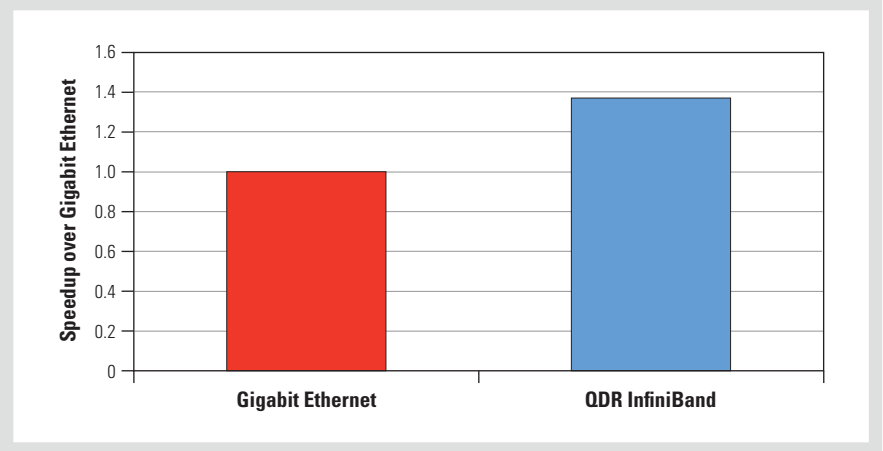

Figure 5. *Relative performance in the High-Performance Linpack tests*

after configuration. The MPI Ping-Pong: Lightweight Throughput and MPI Ping-Pong: Quick Check performance tests offer a simple way to verify the interconnect setup.

BENCHMARKING CLUSTER PERFORMANCE

In August 2009, Dell engineers performed benchmark tests comparing performance over QDR InfiniBand and Gigabit Ethernet fabrics using a Microsoft Windows HPC Server 2008–based cluster of eight Dell™ PowerEdge™ R610 compute nodes and a PowerEdge R710 head node. Each server was configured with two quad-core Intel® Xeon® X5550 processors at 2.67 GHz and 12 GB of RAM at 1,333 MHz. A Dell PowerConnect™ 6248 switch was used for the Ethernet interconnect, while a 36-port Mellanox QDR InfiniBand switch provided the high-speed, low-latency fabric in conjunction with OpenSM running on the cluster head node. The reported results focus on relative performance increase rather than absolute numbers, because there are many ways in which the performance can be further tuned. The test team switched between the InfiniBand and Gigabit Ethernet configurations by changing the network topology in HPC Cluster Manager, with no change required at the application level.

The tests used three standard benchmarks: Intel MPI Benchmarks (IMB), ANSYS FLUENT, and High-Performance Linpack (HPL). IMB is a micro-benchmark suite used for evaluating interconnect performance; it performs MPI operations that measure various characteristics of the network. Figures 2 and 3 show the results from the IMB PingPong test in this suite, which measures latency and bandwidth between two nodes by sending messages with increasing size.

FLUENT is a commonly used computational fluid dynamics (CFD) application in HPC cluster environments, designed to model fluid flow and heat transfer in complex geometries. The team used version 12.0.16 for these tests. Figure 4 shows the QDR InfiniBand performance for several FLUENT tests normalized against Gigabit

Ethernet performance. In these tests, the performance increase was primarily a factor of the communication characteristics of each test. For example, the Aircraft_2m benchmark ran more than 11 times faster when using the QDR InfiniBand interconnect; the results for other benchmarks varied, but all showed significant increases.

HPL is a standard benchmark for evaluating cluster performance, because it makes heavy use of a variety of performance components, including processor speed, memory bandwidth, and interconnect bandwidth. The test team compiled the HPL code using the Microsoft Visual Studio® development system with Intel Math Kernel Library (MKL) 10.2 as the math library. The test team also used the Lizard tuning wizard, a Microsoft tool designed to enhance HPL cluster performance by adaptively tuning the 29 HPL input parameters to find the best set of parameters for the cluster, and then reporting the performance.[2] As Figure 5 shows, using QDR InfiniBand increased performance by 36 percent compared with Gigabit Ethernet.

DEPLOYING HIGH-SPEED, LOW-LATENCY FABRICS

HPC clusters can greatly benefit from a high-speed, low-latency interconnect. Using QDR InfiniBand on clusters running Microsoft Windows HPC Server 2008 can help administrators significantly increase the performance of their clusters, particularly for applications that are sensitive to bandwidth and latency.

Aziz Gulbeden is a systems engineer in the Scalable Systems Group at Dell. He has a B.S. in Computer Engineering from Bilkent University and an M.S. in Computer Science from the University of California, Santa Barbara.

Munira Hussain is a systems engineer and adviser in the Dell High-Performance Computing Group, specializing in HPC systems and architecture design. She has a bachelor's degree in Electrical Engineering from the University of Illinois at Urbana-Champaign.

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[2] The Lizard tool is available at www.microsoft.com/downloads/details.aspx?displaylang=en&familyid=3313856b-02bc-4bdd-b8b6-541f5309f2ce.

ENABLING THE NEXT-GENERATION DATA CENTER: A NETWORK PERSPECTIVE

By Kevin Ryan

Technological advances such as virtualization and cloud computing hold the promise of transforming enterprise IT operations. Deploying highly efficient networking equipment alongside powerful, flexible servers and storage can help create a robust, agile, and cost-effective infrastructure for the next-generation data center.

The data center is in the beginning stages of a major transformation. These changes are the result of a variety of convergent factors, including the following:

- **Changing business models:** Consolidation and outsourcing are providing an opportunity to reduce costs, save power, and flexibly add and scale services.
- **Increased computational density:** A series of technological advancements have come together to provide dramatic increases in computational density as well as power and cost savings. Key advances include multi-core processors, 10 Gigabit Ethernet (10GbE), powerful rack servers and blade servers such as the Dell™ PowerEdge™ M1000e enclosure, and convergent Internet SCSI (iSCSI) storage area networks (SANs) such as the Dell EqualLogic™ PS Series arrays.
- **Cloud computing:** The advent of cloud computing has helped create highly dynamic virtualized environments within enterprise and service-provider data centers.
- **Energy efficiency:** A focus on reducing power consumption has brought attention to the importance of increasing efficiency as a way of controlling carbon emissions and operational expenditures related to data center power, cooling, and space requirements.

As these advancements continue increasing the power and flexibility of IT operations, deploying highly efficient networking equipment that can support the infrastructure as a whole can be essential to success—helping create a robust, agile, and cost-effective infrastructure for the next-generation data center.

MEETING NETWORK CHALLENGES

Increases in computational density along with dynamic virtualization through Microsoft® Hyper-V™, VMware®, Citrix® XenServer™, and other platforms mean that enterprise networks must evolve as well. Enterprises face several challenges that are driving the move to technologies like 10GbE. The first is handling the ever-increasing bandwidth required by each server. When the general rule was one application per server, Gigabit Ethernet was generally sufficient for most data center applications. But today, when a single server may support dozens of applications, 10GbE may be necessary to help meet network demands.

The second challenge is the increasing popularity of iSCSI as a converged SAN storage technology.

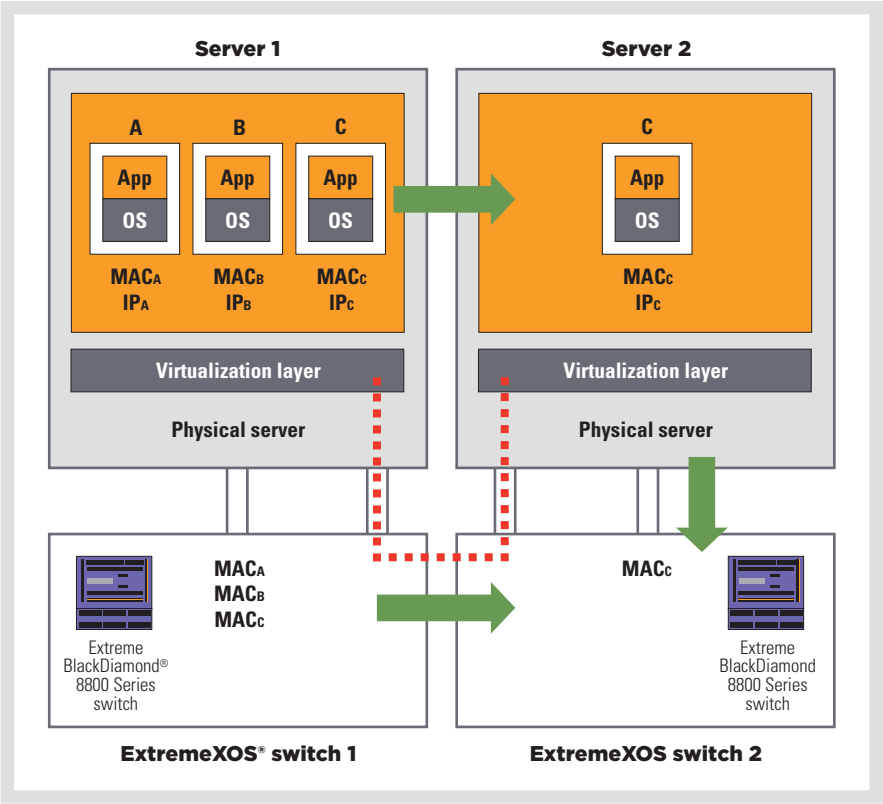

Figure 1. *Switch-level technology from Extreme Networks enables seamless network virtualization*

Before iSCSI storage arrays such as the Dell EqualLogic PS Series were widely available, SAN storage typically ran over a separate Fibre Channel network. iSCSI has enabled the deployment of simplified, cost-effective SANs that utilize the same Ethernet-based networks as other data, further increasing the need for a high-bandwidth infrastructure.

Third, the advent of cloud computing leads to deployments designed to utilize the entire network infrastructure as a shared pool of resources, allowing manual or trigger-based resource reallocation and application movement across the network. Automating this reallocation and movement requires tight integration between the network and the server virtualization environment to help ensure that the necessary network changes can synchronize with the server layer. For example, as applications move across the network, their accompanying network profiles—such as security, quality-of-service, and virtual LAN information—must move with them.

> **"As applications move across the network, their accompanying network profiles—such as security, quality-of-service, and virtual LAN information—must move with them."**

These environments are driving the need for highly agile and automated networks that can keep up with the server layer. Switch-level technology from Extreme Networks is designed to meet the challenges posed by these advances—enabling the network to become virtualized along with the applications, allowing network profiles to bind with applications and migrate seamlessly in real time, and helping realize the promise of virtualization (see Figure 1).

ENABLING THE NEXT-GENERATION DATA CENTER

The way enterprises and service providers build their data centers has changed dramatically—and the implications for networks are profound. Whether supporting high-bandwidth virtualized servers, dynamic cloud computing environments, or energy-efficiency initiatives, highly efficient and scalable networking equipment is critical to enabling the next-generation data center.

Kevin Ryan is the director of data center solutions at Extreme Networks. He has spent the last 20 years in various senior management roles in the IT industry and has been involved in many network and data center technologies, including data center security, software as a service, core networking, fiber to the home, metro Ethernet, and wireless networking.

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INTEGRATING SYMANTEC BACKUP EXEC SYSTEM RECOVERY INTO THE DELL MANAGEMENT CONSOLE

By Troy Lehman

The Dell™ Management Console Powered by Altiris™ from Symantec™ is designed to consolidate disparate management tasks into a single powerful, flexible interface. Using a complimentary plug-in, administrators can integrate Symantec Backup Exec™ System Recovery installations with this console to help centralize and simplify control over servers and clients in their environments.

To help effectively manage their environments, IT administrators often use multiple independent software tools to address challenges related to systems management and other tasks. Although this approach can have its advantages, the adoption of multiple independent tools can also add complexity, with each tool requiring its own incremental hardware, licensing, and training.

The Dell Management Console Powered by Altiris from Symantec is designed to simplify IT administration by consolidating disparate aspects of systems management, security, and data protection into a single powerful, flexible tool. Organizations can take advantage of the complimentary Symantec Backup Exec System Recovery Management Solution (BESR-MS) plug-in to integrate their BESR installations into this tool. Together, the Dell Management Console and the BESR-MS plug-in help centralize and simplify management of BESR-protected servers and clients—offering a range of advantages for administrators, including centralized BESR deployment through an intuitive interface, centralized backup policy creation and management, centralized backup status reporting, and alert-triggered backup and restore processes in response to administrator-defined criteria.

FLEXIBLE, EXTENSIBLE PLATFORM

The Dell Management Console is a complimentary hardware management application included with Dell PowerEdge™ servers. It is designed to provide a single view into the IT infrastructure and, through integration with Dell OpenManage™ agents, enables administrators to monitor and report on Dell servers, storage, switches, clients, and printers at a high level of detail. The basic console software itself incorporates features for hardware discovery, inventory, and health monitoring as well as BIOS upgrades, reporting, and alerting.

The BESR-MS plug-in, available as a complimentary download for use with purchased copies of BESR, enables administrators to use the Dell Management Console to discover and centrally manage BESR installations in their environments, including viewing backup status, remotely scheduling backup jobs, and remotely deploying new BESR licenses (see Figure 1). BESR is designed to act as a one-to-one agent protecting individual Microsoft® Windows® OS–based servers or clients. It takes multiple snapshots of the entire OS—including system settings and application configurations—to enable rapid, comprehensive system restore functionality to multiple points in time. In addition to supporting bare-metal recoveries on the original hardware, BESR can be configured to restore a system image to dissimilar hardware. In virtualized environments, it can also be scheduled to automatically

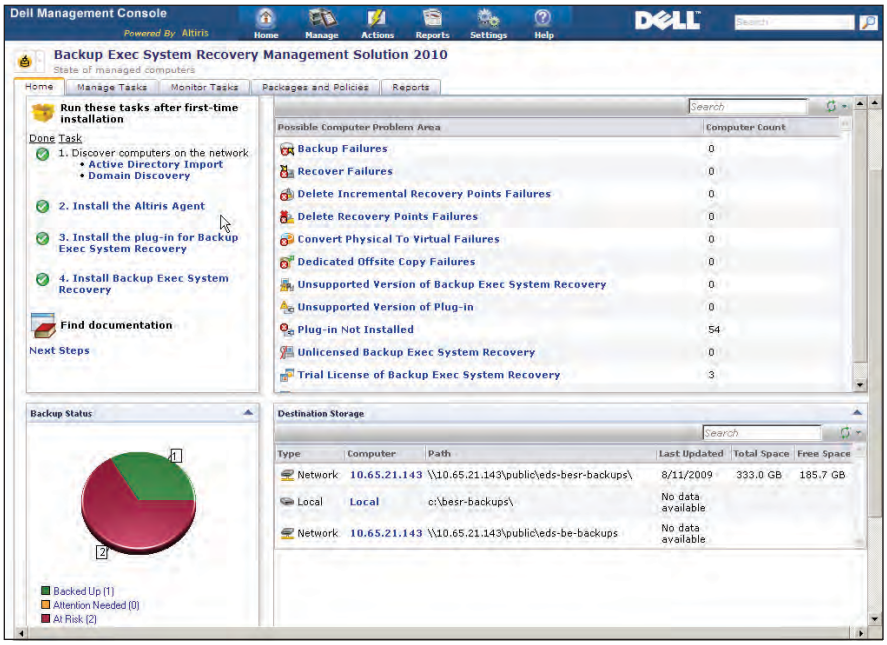

Figure 1. *Symantec Backup Exec System Recovery Management Solution in the Dell Management Console*

convert backup images to virtual images (such as .vmdk or .vhd files), providing a valuable tool for physical-to-virtual migration projects.

Because the Dell Management Console is based on the modular Symantec Management Platform architecture, administrators can also take advantage of other plug-ins to help them deploy and manage a variety of Symantec applications, including the Altiris Server Management Suite™, Altiris Client Management Suite™, and Symantec Endpoint Protection solutions. The consistent interface, common data model, and single configuration management database (CMDB) used by these plug-ins can help administrators efficiently deploy, manage, and license their environments; automate key management tasks; and gain a broad view of the health of their IT environments through a single console.

CENTRALIZED BESR DEPLOYMENT

As with other solutions that integrate with the Symantec Management Platform framework, administrators can install the BESR-MS plug-in using the Symantec Installation Manager (SIM). On launch, the SIM screen lists the Dell Management Console plug-ins that are currently installed and those that are available for installation, enabling administrators to download and install the BESR-MS plug-in through a simple point-and-click process.

The initial BESR-MS installation automatically creates a software package comprising the installation scripts and files required for automated remote deployments of the BESR application itself. After installing the plug-in, administrators can immediately use this package and associated options in the Dell Management Console to roll out the BESR application to managed systems. Comprehensive automation helps dramatically streamline the deployment process, avoiding the need for administrators to manually create packages, tasks, or scripts.

CENTRALIZED BACKUP POLICY CREATION AND MANAGEMENT

BESR runs locally on each server or client, and by default each application instance is managed independently. The BESR-MS plug-in, however, enables administrators to centralize this management in the Dell Management Console. From there, they can create customized backup policies that can then be applied globally or to administrator-defined subsets of managed servers or clients. The console also supports a wide range of flexible scheduling options to help ensure that data protection activities meet organizational requirements.

CENTRALIZED BACKUP STATUS REPORTING

Integrated dashboards for real-time operational monitoring are fundamental

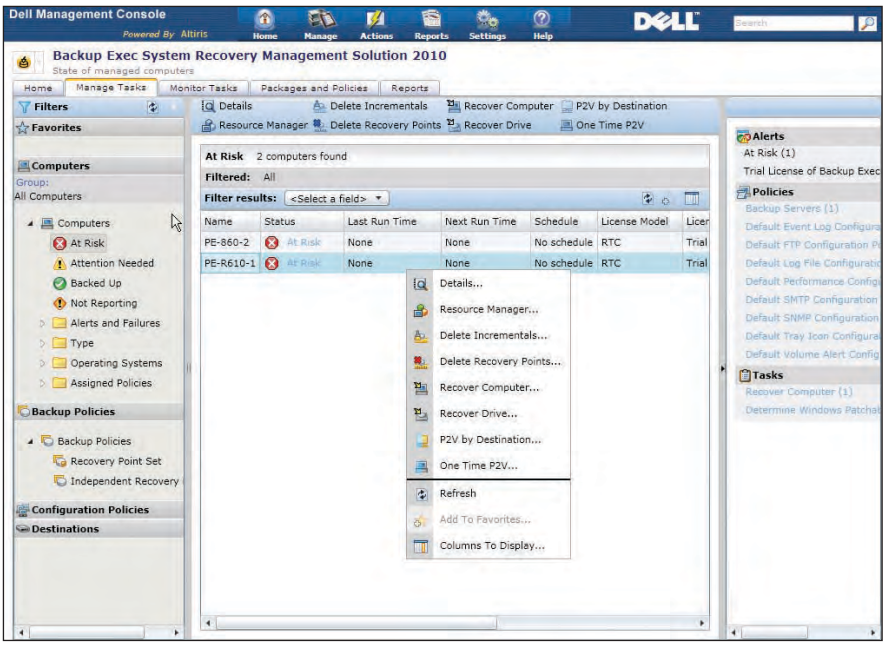

Figure 2. *Symantec Backup Exec System Recovery Management Solution backup status*

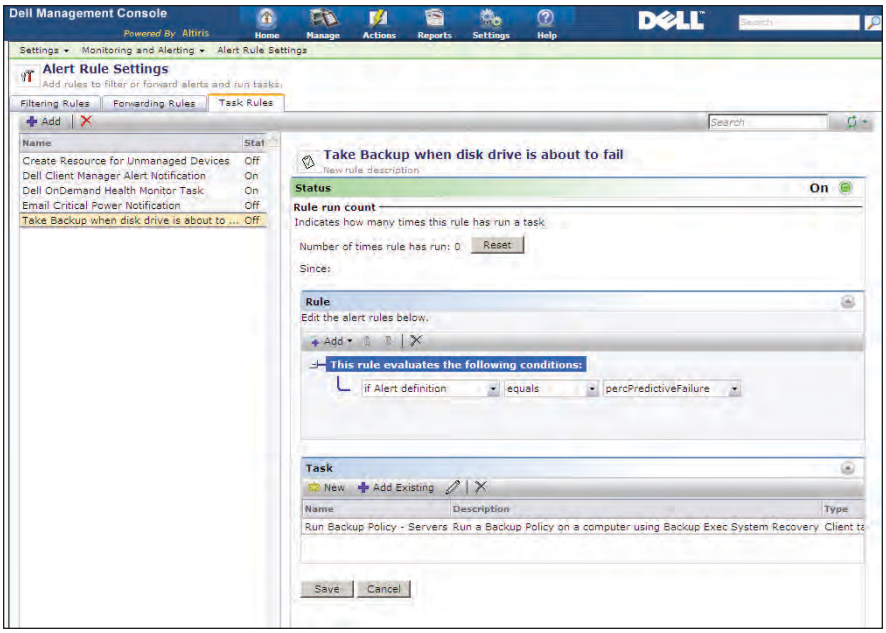

Figure 3. *Symantec Backup Exec System Recovery Management Solution alert rule settings*

to a mature backup and recovery solution. In addition to the graphically presented general overview on the main portal page, the BESR-MS plug-in offers a variety of granular reports to help administrators easily monitor managed systems, including the following:

- **Backup status:** Provides a consolidated view of the backup status of all managed systems, denoting each backup as At Risk, Needs Attention, or Backed Up (see Figure 2)
- **Recovery point objective:** Lists the most recent recovery point available for all managed systems, allowing administrators to gauge compliance with organizational recovery point objectives
- **Volume capacity:** Lists the disk utilization of a production system as well as capacity levels of target storage areas to enable planning for additional storage capacity requirements

ALERT-TRIGGERED BACKUP AND RESTORE PROCESSES

Administrators can configure managed systems to generate status messages using standard protocols such as Simple Network Management Protocol (SNMP). When received, status messages from different protocols are converted from their native format into a common Dell Management Console format called an alert. Each alert has a status of New, Acknowledged, or Resolved, and can indicate one of many severity levels ranging from Normal to Critical.

Administrators can also configure the Dell Management Console to execute a BESR backup or execute multiple independent tasks—such as backing up, restoring, copying to an off-site location, or converting to a .vmdk file—in response to an alert. For example, on receiving a Dell predictive disk failure alert, the event console can trigger a job containing multiple tasks that immediately back up that server and then convert the backup image to a virtual machine. Administrators can then easily launch this virtual machine while the original server is taken offline for repair.

Importantly, the process of linking backup tasks with incoming alerts is designed for simplicity and ease of use, without requiring advanced configuration or scripting (see Figure 3). Administrators can quickly and easily configure alert-triggered backup and restore processes because the underlying tasks required to configure those processes are automatically created when the BESR-MS plug-in is first installed.

COMPREHENSIVE SYSTEMS MANAGEMENT

The Dell Management Console is designed to provide a comprehensive life cycle management platform that can enhance quality of service while helping reduce the costs of ownership and management associated with IT resources. By incorporating the complimentary BESR-MS plug-in into this console, organizations using BESR to help protect their Microsoft Windows–based systems can take advantage of the management capabilities of the console to schedule and automate BESR deployments across the enterprise, trigger backup and restore processes based on alerts, and more. And because the Dell Management Console is based on the Symantec Management Platform, it can also provide seamless integration with Symantec solutions for systems management, security, and data protection as well as many other third-party plug-ins—offering a powerful, flexible way for administrators to manage a wide range of software across their IT environments.

Troy Lehman is a senior technical strategist at Symantec currently focused on backup, recovery, and archiving strategy and enablement within Dell.

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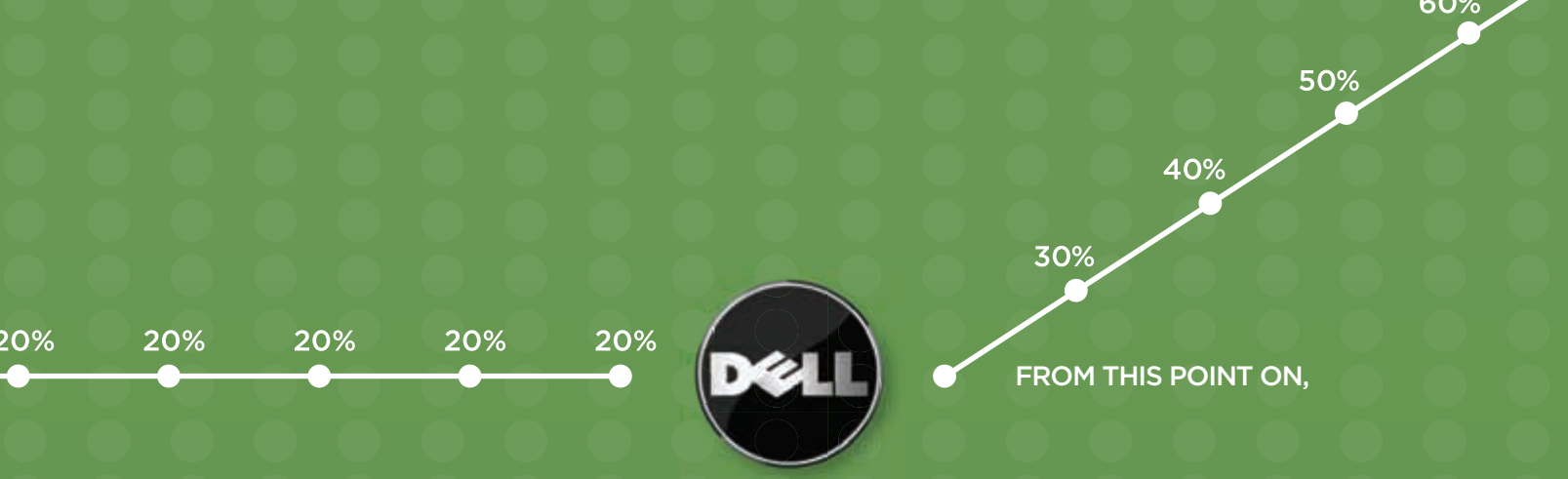

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STREAMLINING DELL SERVER AND CLIENT MANAGEMENT WITH THE NETX APPLIANCE

By Keith Saltstein

Designed for rapid deployment, the NetX Appliance—based on Dell™ hardware, the Dell Management Console, and optional Altiris™ Client Management Suite™ software from Symantec—provides a simple, cost-effective way for administrators to centrally discover, monitor, manage, and update Dell servers and clients throughout their organizations.

Choosing a systems management solution to help track, manage, and troubleshoot servers and client systems can be critically important. But the selection process can also be far from simple—requiring consideration of not only the features and functionality of each possible solution, but also factors such as implementation, training, scalability, ease of use, support, and overall cost.

The NetX Appliance—based on Dell hardware, the Dell Management Console, and optional Altiris Client Management Suite software from Symantec—is designed to help administrators quickly deploy a simplified, integrated management solution that they can use to centrally discover, monitor, manage, and update Dell servers and clients throughout their organizations. By helping to streamline both initial implementation and ongoing management, the NetX Appliance enables administrators to shift their efforts from managing their management tools to solving IT problems, automating tasks, and contributing to their organization's success.

COMPREHENSIVE MANAGEMENT FEATURES

The NetX Appliance is designed for rapid deployment right out of the box using a simple three-step configuration process (see Figure 1). The hardware is built and supported by the Dell Custom Factory Integration service and includes an extendable one-year warranty for on-site, next-business-day service, while the Altiris software includes phone-based technical support from Symantec. The appliance supports management of up to 3,000 client systems from a single Web browser–based console.

The NetX Appliance comes in a basic and an enhanced configuration. The basic configuration is based on a Dell PowerEdge™ R200 rack enclosure with dual-core Intel® Xeon® processors, 4 GB of RAM, two 250 GB Serial ATA (SATA) drives in a RAID-1 mirrored configuration, a single power supply, and the Microsoft® Windows Server® 2003 OS. The enhanced configuration—which should be considered for organizations planning to run additional Altiris software—uses quad-core Intel Xeon processors, two 500 GB SATA drives, and a redundant power supply.

The included Dell Management Console software is designed to provide a single view into the IT environment, including discovery, inventory, reporting, hardware monitoring, OS monitoring, and hardware update functionality for Dell systems. The Altiris Client Management Suite software, which can be activated as a separately licensed add-on, adds a wide range of management functionality, including the following:

- **Comprehensive inventory:** Ability to inventory virtually any system, including those running Microsoft Windows®, Novell® NetWare®, Linux®,

UNIX®, and Mac OS X operating systems as well as handheld and network devices

- **Software distribution:** Secure, bandwidth-sensitive distribution of applications and updates across local area networks (LANs), wide area networks (WANs), and remote and mobile clients
- **Ghost image deployment:** Automated OS deployment, system configuration, PC "personality" migration, and software deployment across multiple hardware platforms and operating systems, including the Microsoft Windows Vista® and Windows Server 2008 operating systems
- **Hardware update distribution:** Ability to push agent, BIOS, driver, and firmware updates to Dell systems, including options to download the latest updates from the Dell Web site on a scheduled basis
- **OS monitoring:** Monitoring of processor, memory, drive capacity, and I/O utilization; historical reports or live graphs for monitored devices; and alerts based on administrator-defined thresholds
- **Dell client management:** Powerful hardware management for Dell OptiPlex™ desktops, Dell Latitude™ laptops, and Dell Precision™ workstations using Dell Client Manager software, including the ability to collect BIOS settings and hardware values, monitor critical systems for hardware alerts or status changes, upgrade BIOS versions, or change BIOS settings across multiple systems from a centralized console (see Figure 2, showing the Dell Client Manager Plus add-on)
- **Application usage monitoring:** Application usage monitoring of client systems, including the ability to deny application use and identify unused licenses (in conjunction with Altiris Inventory Solution™ software, available as a separately licensed add-on)
- **Patch delivery:** Ability to scan managed systems for security vulnerabilities, generate reports from scan

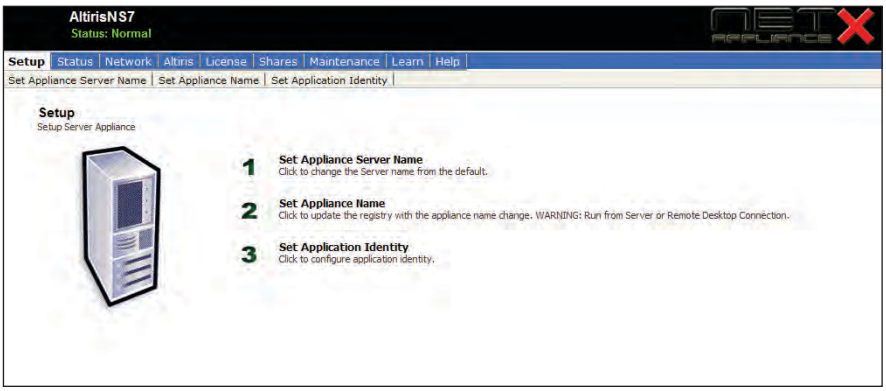

Figure 1. *Simple three-step configuration process for the NetX Appliance*

Figure 2. *Dell Client Manager Plus portal page in the Dell Management Console*

"The NetX Appliance is designed to help administrators quickly deploy a simplified, integrated management solution that they can use to centrally discover, monitor, manage, and update Dell servers and clients throughout their organizations."

TAKING CONTROL WITH THE NETX APPLIANCE

Delsea Regional School District provides IT services to three school districts in southwest New Jersey—Delsea Regional High School District, Franklin Township Public Schools, and Elk Township Public Schools—with a total of 1,300 Dell desktops and laptops distributed across nine buildings. Until recently, managing, remediating, and refreshing those client systems was a major challenge. "Everything was basically sneakernet," says Greg Taylor, shared services technology coordinator for Delsea. "We did a lot of traveling between buildings, and we had to jump through all kinds of hoops to get to someone's computer and work on it."

As the 2008–2009 school year came to a close, Taylor decided to look for a better way. After a product evaluation, he decided on Altiris Client Management Suite for three reasons. "Number one, I've seen Altiris Client Management Suite in action at other school districts, and I knew that I would be completely happy with it," he says. "Number two, I was able to get a specialized version of the product, called Altiris Management Suite for Dell Clients, that builds upon the existing free hardware management capabilities of Dell Client Manager. Third, I was able to get a preconfigured, appliance-based version of the solution through Symantec Platinum Partner NetX Inc."

> **"NetX left us feeling comfortable, and they were very efficient. The difference in how we're spending our time now is remarkable—it's like typing a document on a computer versus carving it out on a stone tablet."**
>
> —Greg Taylor
> Shared services technology coordinator
> for Delsea Regional School District
> July 2009

By using the NetX Appliance, Taylor avoided the need to install an OS and Microsoft SQL Server® database platform, both of which were done ahead of time. Within five business days, Taylor and his two-person staff were fully trained on the solution, and the Altiris agents had been pushed out to the 750 endpoints—the original number budgeted. "NetX left us feeling comfortable, and they were very efficient," says Taylor. "The difference in how we're spending our time now is remarkable—it's like typing a document on a computer versus carving it out on a stone tablet. We started seeing value from the solution right away, so we were able to get budget approval to roll it out to the 550 client machines at Franklin Township as well."

Taylor and his staff can now image PCs, deploy software to client systems, and troubleshoot remotely without driving out to the campuses, enabling the team to install and configure 192 new Dell clients in just three weeks. "Altiris products are going to cut down on our travel by at least 25 percent, if not by half," says Taylor.

By helping eliminate the manual process of gathering compliance data, the Altiris software has also significantly improved patching compliance and endpoint protection for Delsea. "We're pretty close to 100 percent patch compliance now, whereas before we were around 75 percent or less," says Taylor. "I also discovered through the reports that we had 15 endpoints that had no antivirus protection, for whatever reason. So I created a task within the product that if it finds an unprotected computer, it will automatically install antivirus. So now I can say I know for a fact that we have antivirus on every computer."

With the time-saving features of Altiris Management Suite for Dell Clients, Delsea will not need to hire an additional desktop support technician in the near future—meaning that payback on the solution will be achieved in less than one year, says Taylor. The Altiris software may also allow the district to help the community by providing shared IT services to other local entities as well. "As all the districts expand, we have talked about possibly providing services to the local municipality—the police department, for example," says Taylor. "How far we can stretch as humans is very limited. Symantec is helping us stretch farther."

results, and automate the downloading and distribution of Microsoft security patches

- **Power management:** Intuitive power management policies to help save energy and related operational costs
- **Remote control:** Web-hosted remote control to help accelerate problem diagnosis and resolution
- **Reporting:** Over 800 built-in reports and the ability to easily create customized reports to help track virtually every aspect of the IT infrastructure

For an example of how one organization took advantage of the NetX Appliance and Altiris Client Management Suite to simplify and streamline IT management, see the "Taking control with the NetX Appliance" sidebar in this article.

REDUCED DEPLOYMENT COSTS

Automation can help significantly streamline systems management tasks for administrators, helping to reduce costs and increase stability, security, and consistency throughout the IT environment. However, maintaining point solutions from multiple vendors to accomplish this automation can present its own challenges: in addition to requiring time and effort to learn each tool and keep them up-to-date, nonintegrated or proprietary solutions often cannot evolve effectively to meet changing requirements.

The Dell Management Console, included with the NetX Appliance, is designed not only to provide a holistic view of the IT environment, but also to support modular plug-ins that can extend

	Traditional installation (reprovisioning existing hardware from bare metal)	Traditional installation (deploying new hardware)	NetX Appliance
Hardware and software*			
Hardware	N/A	US$2,225	US$2,995
Microsoft Windows Server 2003 Standard Edition	US$799	Included	Included
Total hardware and software cost	US$799	US$2,225	US$2,995
Services**			
Software installation and configuration	US$1,900 (1 day)	US$1,900 (1 day)	US$237.50 (1 hour)
Altiris Client Management Suite installation and configuration	US$1,900 (1 day)	US$1,900 (1 day)	Included
Total services cost	US$3,800	US$3,800	US$237.50
Total installation cost	US$4,599	US$6,025	US$3,232.50

* Hardware and software costs are listed as shown at DELL.COM as of October 15, 2009, for Windows Server 2003 Standard Edition and a Dell PowerEdge R200 server configured with dual-core Intel Xeon E3110 processors at 3.0 GHz; 4 GB of RAM; a Dell Serial Attached SCSI (SAS) 6/iR SATA/SAS controller for two drives in a RAID-1 configuration; two 250 GB, 7,200 rpm SATA hard drives; and Windows Server 2003 Standard Edition. NetX Appliance cost is for the basic configuration as of October 15, 2009.

** Services costs assume a rate of US$237.50/hour (based on US$9,500/week for 5 standard business days), with assumed length of service time specified in parentheses. Software installation and configuration tasks consist of installing and configuring RAID, the OS, patches, drivers, Microsoft SQL Server, Microsoft IIS, Microsoft ASP.NET, and additional utilities, as well as installing and configuring Altiris Client Management Suite to roll out agents.

Figure 3. *Example Dell Management Console deployment costs comparing traditional installations with a NetX Appliance*

its functionality to help manage many different types of software, including many Altiris solutions from Symantec. The consistent underlying technology for each module helps simplify the learning process for administrators as they incorporate additional plug-ins.

Although reprovisioning existing hardware would seem to be the most cost-effective way of implementing the Dell Management Console, deploying a dedicated appliance can actually be substantially less expensive. The NetX Appliance is optimized and uses a best-practice configuration that enables it to be significantly more responsive than a standard installation, while enabling IT staff to avoid time-consuming configuration and deployment processes. For example, assuming that reprovisioning would require two days of work from an experienced engineer to carry out a bare-metal installation and configuration on the server—including optimizing the database and Microsoft Internet Information Services (IIS) to a best-practice configuration—the rapid deployment possible with a dedicated appliance could potentially save up to around US$1,300 in total installation costs (see Figure 3). For organizations that would purchase and deploy a new server using hardware comparable to the NetX Appliance, the appliance could potentially save up to around US$2,800. In addition to these cost savings, in this example scenario, IT administrators would gain two days of valuable time that they could spend familiarizing themselves with the management system rather than performing software installation and configuration tasks.

STREAMLINED SYSTEMS MANAGEMENT

Although automation can help significantly simplify systems management, implementing an appropriate solution can also be costly and time-consuming, especially for small businesses. By enabling rapid, cost-effective deployment of a dedicated management system, the NetX Appliance can help dramatically reduce these deployment costs and enable administrators to quickly gain the advantages of the flexible, extensible Dell Management Console and Altiris Client Management Suite for Dell server and client management.

Keith Saltstein is the founder of NetX Information Systems, a Symantec Platinum Partner, recently listed as a CRN Fast Growth 100 company.

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PREPARING FOR E-DISCOVERY: SETTING SMART POLICIES FOR BACKUP AND ARCHIVING

By Mathew Lodge

Without smart information management policies, e-discovery can be an expensive and time-consuming proposition. Preparing now and using an active archiving system can help dramatically reduce storage requirements, e-discovery costs, and information risk.

Information management—the processes and technologies used to acquire, retain, hold, and ultimately expire information—is a fundamental part of IT. In the context of litigation, however, it is also fraught with potentially costly pitfalls. During discovery proceedings, rapid access to information on backup and archiving systems can be critical to avoiding major costs related to restoring and then searching through several years' worth of data to locate relevant items. U.S. court rulings have repeatedly demonstrated that companies may be called on to produce requested data even at major expense to the organization—which is why business and technology executives care about information management, understanding the key differences between backup and archiving, and setting smart policies that take advantage of tools such as active archiving to help ensure their organizations are prepared.

BACKUP, ARCHIVING, AND E-DISCOVERY

The complexities surrounding the discovery of information from backup tapes was thrown into stark relief in the now-infamous *Zubulake v. UBS Warburg LLC* case. The Committee Note to U.S. Federal Rule of Civil Procedure 26(b)(2) states that information may be subject to legal hold even if it is determined to be not reasonably accessible. *Zubulake* demonstrated that whether information is *accessible* or *inaccessible* depends on how readily usable the storage format is. It is clear from the challenges associated with locating information on traditional backups that they were not designed for e-discovery—and it shows.

In *Toussie v. County of Suffolk*, for example, the county argued that searching tape backups of e-mail messages was overly burdensome, requiring restoration of 470 backup tapes at an estimated cost of between US$418,000 and US$963,500. Why so much? Computer backups are snapshots of a system at a particular point in time, which enables recovery of the system back to that point in the event of a system failure or natural disaster. The entire backup process is optimized around that concept of a system image at a singular point in time—whereas e-discovery is about finding specific information within a particular time period. The *Toussie* request was similar to being asked to find every photo of Aunt Petunia in a green dress during the 1970s when faced with 47 shoe boxes of family snapshots: the only option is to open all the boxes and look at all the images. In this particular case, even narrowing the search terms was little help to the county. With no way of knowing which backup tapes matched the terms, restoring the tapes was the only way to find out.

Unfortunately, knowing which backup tapes or images are relevant is not the only problem. Most backups are of a particular system configuration, which often must be restored to the same hardware as the original system. This presents a major challenge, because organizations often have hardware refresh cycles of two to four years—meaning that the

chances of finding the same hardware may be slim for all but the most recent backups. Restoring older backups could require scouring online sites for used legacy hardware or resorting to specialized backup restoration services.

In general, tapes kept solely for disaster recovery are not likely to be defined as accessible. However, many restores from backups are not for disaster recovery—they are to retrieve deleted information. Indeed, that requirement is why Symantec™ Backup Exec™ and Veritas™ NetBackup™ software is designed to make it easy to recover a single item, such as a file or e-mail message. Some organizations have attempted to hide behind accessibility, but if information is relevant and not readily accessible elsewhere, backups may be deemed to be accessible. In *Toussie*, the fact that there was no other way to get the data was relevant, leading the court to state, "You can't just throw up your hands and say we don't store [e-mails] in an accessible form and then expect everybody to walk away."

The concept of accessibility has become pivotal, and the problem is that many backups may satisfy its definition. To determine the accessibility issue, courts may want to know whether a party routinely restores backup tapes (for example, to test that the tapes still work) or whether tapes have been restored in other situations (for example, to restore an accidentally deleted file or e-mail). Courts may also ask whether projected costs have been compared with prices from specialized vendors, who may turn out to be cheaper than in-house recovery because of their experience and tools.

ACTIVE ARCHIVING AND KEY MANAGEMENT STRATEGIES

Active archiving systems were developed to address these problems. Most organizations perform archiving in one form or another; for some, however, that archiving means a pile of backup tapes somewhere. Active archiving is different, providing a way to centrally manage the storage, retention, and legal hold of information while helping ensure live (or active) access to virtually any item. Active archives are indexed so that information can be rapidly retrieved for business, regulatory, or e-discovery purposes.

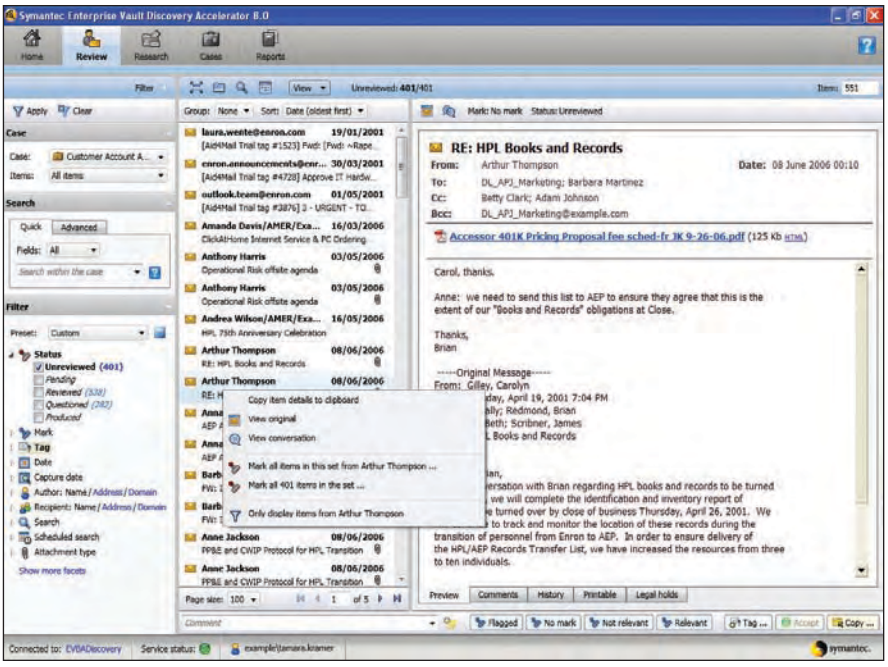

Figure 1. *Symantec Enterprise Vault Discovery Accelerator facilitates rapid search and recovery of archived data*

Active archiving works by moving information out of e-mail and other systems into a central repository—the archive. Although the information may be gone from the original application, active archiving software such as the Symantec Enterprise Vault™ application works behind the scenes to provide access to archived items with minimal disruption to end users, while the Discovery Accelerator option helps simplify search and recovery for e-discovery processes (see Figure 1). For example, archived e-mails still show up in end users' e-mail clients, and double-clicking on a message would open it like any other message. On the back end, the software has retrieved the item from the archive and passed it back to the e-mail client, enabling end users to continue using their e-mail—including replying to and forwarding messages—just as they normally do.

Establishing e-discovery preparedness starts with a partnership between the legal department and IT, human resources, and records management groups working to identify the most relevant information, which typically means financial data as well as sales and

> **"A great policy with no control over information leaves organizations exposed to substantial risk until they have a scalable, automated method to control e-mail, instant messages, files, and other unstructured data."**

customer information. A key priority should be quickly setting a broad policy and getting information under control, which can offer a rapid and significant return on investment. A comprehensive, detailed set of policies comes through refinement: organizations should avoid letting the "perfect policy" be the enemy of good, basic information governance. After they have information under automated control—through systems such as an active archive—they can implement and then refine basic retention and deletion policies to support e-discovery accessibility. A great policy with no control over information leaves organizations exposed to substantial risk until they have a scalable, automated method to control e-mail, instant messages, files, and other unstructured data.

Although the cost of active archiving can potentially be recouped in a single case (think of the hundreds of thousands of dollars in estimated costs from *Toussie*), active archiving can also offer immediate advantages to IT staff. Unstructured information such as e-mail, instant messages, and files are a rapidly growing storage area. And because information is growing far faster than storage unit costs are declining, the net effect is that storage purchases are often consuming more and more of enterprise IT budgets, squeezing out other projects. Active archiving systems can help dramatically reduce storage requirements by identifying and eliminating data duplication or redundancy. For example, consider an e-mail with a 3 MB attachment that is received by 100 people, saved to disk 50 times, and uploaded 10 times. An active archiving system can store that attachment just once, and then simply record that the same file is being used the remaining 159 times. A Symantec-sponsored analysis of one large company found that using Symantec Enterprise Vault helped reduce the company's storage requirements by approximately 40 percent while reducing time spent on discovery processes by an estimated 90 percent—saving thousands of dollars in hardware and labor costs.[1]

> **"Active archiving systems can help dramatically reduce storage requirements by identifying and eliminating data duplication or redundancy."**

Active e-mail archiving can also provide automated mechanisms to help ensure legal hold. The alternative is typically to try and hold the item "in place," often on a laptop or hard drive. Although this sounds simple, any accidental or deliberate loss can mean that the item is gone and that the duty to preserve it has been violated. Keeping a central, managed copy of the item in an archive can help ensure that it is stored securely until it is no longer required, and then automatically deleted.

In addition, active archives can help dramatically accelerate early case assessment and review. Because the information is already indexed, archives can be easily searched, helping avoid the need to restore backups or outsource collection and review. This rapid access to information can enable in-house and outside legal counsel to make strategy decisions before undertaking more expensive and time-consuming discovery efforts.

COST-EFFECTIVE INFORMATION MANAGEMENT

Courts are becoming less and less tolerant of excuses made during the discovery process that derive from a failure to maintain proper information management processes. Although traditional backups were not designed for e-discovery, many organizations still rely on them for information retrieval—and may pay the price in both time and money if the backups are deemed accessible during litigation.

Although there is no single perfect answer, an e-discovery preparedness partnership between legal, IT, human resources, and records teams can quickly identify basic information management approaches, and then implement those approaches to help dramatically cut storage requirements, e-discovery costs, and information risk. In combination with active archiving software such as Symantec Enterprise Vault, this strategy can help organizations ensure that they are ready to deal with e-discovery quickly and cost-effectively.

Mathew Lodge is a senior director of product marketing for the Symantec anti-spam and e-mail archiving product set. He has a master's degree in Computer Systems and Software Engineering from the University of York and is a graduate of the Advanced Development Program at London Business School.

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[1] "Business Value Analysis Study: Email and Document Archiving, E-discovery, and Compliance," by Greg Malacane, Alchemy Solutions Group, December 2007, available at www.symantec.com/business/solutions/customer_success/detail.jsp?cid=ing_investment_management.

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