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2010 ISSUE 1 • US$18.95 CAN$19.95

VIRTUAL CLIENTS

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VIRTUAL CLIENTS FOR THE EFFICIENT ENTERPRISE

STK NO: DPS-201001-US

2010 ISSUE 1

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By Timothy Sherbak

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Tom Kolnowski
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We told you it was coming—now it's here. Delivered as a supplement to this issue of *Dell Power Solutions* Magazine, the *Windows 7 Migration Guide* is a stand-alone, 52-page glossy magazine designed from the ground up to help IT professionals plan and manage broad Microsoft® Windows® 7 migrations across their organizations. Our editors, writers, contributors, and creative teams have doubled their efforts to bring you a collection of the latest in Windows 7 guidance across the four key migration phases: Plan & Assess, Design & Build, Deploy, and Manage & Support. Beginning with the cover story, "Mapping Out an Efficient Migration Strategy," the guide consists of 10 in-depth articles in the usual *Dell Power Solutions* technical journal style, plus 4 real-world Windows 7 case studies from deployments in Australia, the UK, and the US.

So, how can you locate the *Windows 7 Migration Guide?* Here is some guidance on finding the nearest copy in print or digital format:

- Look inside the *Dell Power Solutions* postal polybag: If you received a polybagged version of *Dell Power Solutions* 2010 Issue 1, the guide should be tucked inside.
- Click into it from the *Dell Power Solutions* Digital Edition e-mail: If you received an e-mail announcement for the *Dell Power Solutions* 2010 Issue 1 Digital Edition, a copy of the guide has already been reserved for you in our book-reader form. You can follow the link in the e-mail for one-click access, or log in to your Digital Edition account from powersolutionsdigital.dell.com and select the guide from the back issues tab.
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In addition to the *Windows 7 Migration Guide*, the IT Expert Voice community is an excellent source for Windows 7 deployment advice: check them out at www.itexpertvoice.com. And the micro-site at DELL.COM/Windows7Enterprise is another good source for the latest information on Windows 7 events and resources.

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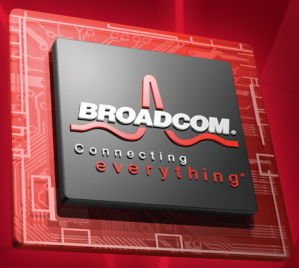

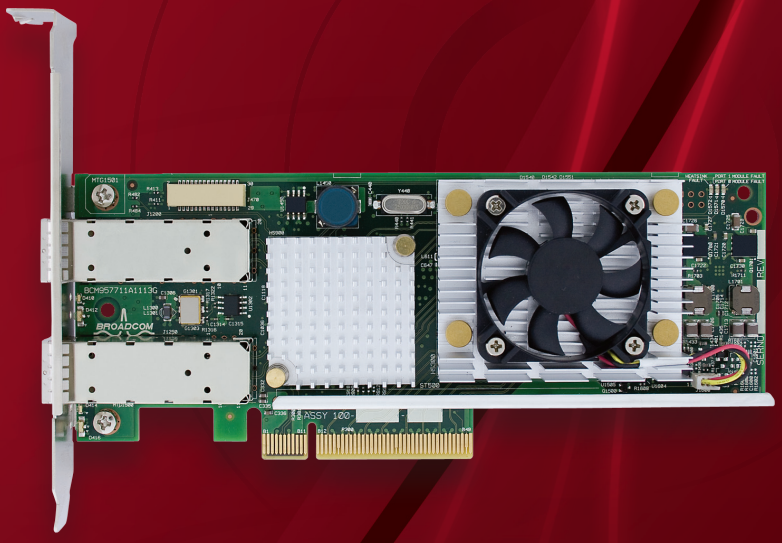

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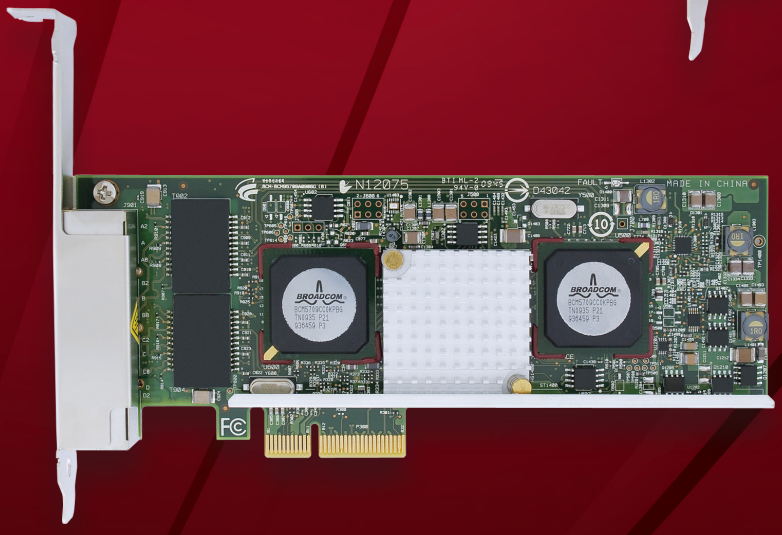

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VIRTUAL CLIENTS
FOR THE EFFICIENT ENTERPRISE

By Roberto Ayala and Juan Vega

By shifting the focus from physical systems to end-user digital identities, the Dell™ Flexible Computing framework helps simplify image management, hardware transitions, and security through central IT control of virtualized client devices. Now, alternative desktop models enable enterprises to achieve measurable efficiency gains thanks to technology advances such as PC-over-IP technology, composite images, and client hypervisors.

Years of mergers, acquisitions, and ad hoc growth can saddle organizations with a hodgepodge of systems, software, and data that drain IT resources, undercut worker productivity, and compromise business agility. To succeed in today's tricky economy, business and technology leaders are working together closely to wring out inefficiencies, reduce fixed operating expenses, and free up assets to invest in innovation.

Traditional enterprise desktop environments are undergoing scrutiny because of growing costs for support and maintenance, compounded by the necessity for frequent security patches and software upgrades. At the same time, end-user desktops have become increasingly difficult to manage as the explosion of remote and mobile workers continues to transform the client computing landscape. These users require immediate access to sophisticated enterprise systems from a diverse range of client devices, while IT groups must contend with time-consuming client management tasks such as deploying and patching images, managing hardware transitions, and ensuring client security.

Faced with these demands and today's budget constraints, many organizations are exploring virtual client models. This approach helps simplify operations and get client assets under control through a fundamental change in perspective: instead of managing physical desktops and hardware devices in various locations, administrators enable access to data, settings, applications, operating systems, and IT policies that are uniquely associated with each user. This information, referred to as the user's *digital identity*, resides in a central location on the network and allows individuals to access and work with their data from any supported device.

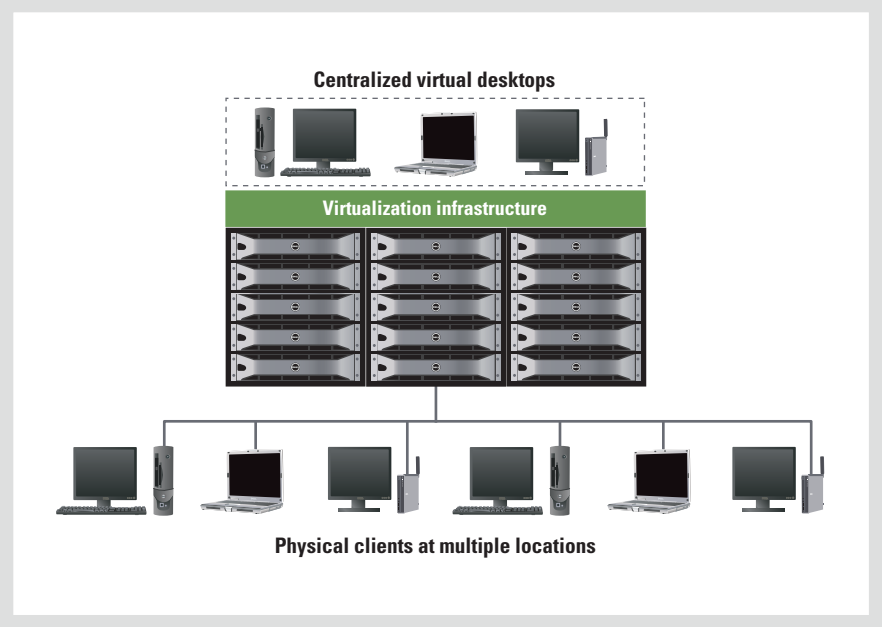

Figure 1. *Dell Virtual Remote Desktop model for centralized distribution of desktops to remote locations and mobile users*

Unlike previous server-based computing models, this framework takes advantage of client virtualization and desktop streaming technologies to expand the scope of client functionality, flexibility, and devices. Technology advances such as Teradici PC-over-IP technology, composite images, and client hypervisors are making virtual client computing an increasingly attractive option. These strides enable organizations to boost productivity and innovation by providing end users with comprehensive functionality and seamless mobile access, while simultaneously helping IT groups to centralize, streamline, and simplify client management and security.

EVALUATING DELL FLEXIBLE COMPUTING OPTIONS

The Dell Flexible Computing framework offers a suite of products and services that are designed to simplify management by enabling a customized user experience with server-based control of digital identities. Dell offers three service-backed client architectures that can be integrated into existing infrastructure to centralize end-user resources.

Designed for stationary environments where manageability and security are critical, the Dell On-Demand Desktop Streaming™ (ODDS) solution optimizes the user computing experience through local processing. With ODDS, the user's data resides on centralized servers that stream the data to local, typically diskless computers. Client storage resides on the server. Each diskless desktop boots from networked storage but retains processor and user interface functions.

Delivering the capabilities of a high-performance workstation in a one-to-one relationship between a local user and a remote workstation, the Dell Dedicated Remote Workstation (DRW) solution allows physical workstations to be moved away from sensitive locations such as hospital operating rooms or securities trading floors. The entire physical workstation is located centrally, and the user accesses the display through a portal device.

Of the three, the Dell Virtual Remote Desktop (VRD) solution is applicable to the widest range of usage scenarios—and is particularly well suited to highly mobile workers who may use a variety of devices from different locations. By leveraging VMware® or Citrix® software, it gives users access to server-based virtualized desktops from a wide range of devices, including desktops, laptops, thin clients, and PDAs (see Figure 1). Storage and processor functionality are offloaded to the server and virtualized, while the client device performs lightweight graphics processing and user interface functions.

The Dell VRD approach utilizes an array of optimized hardware and software platforms designed to reduce the complexity of managing traditional physical desktops—including the Dell FX100 remote access device, Dell OptiPlex™ desktops or thin clients, Dell Latitude™ laptops with Latitude ON™ technology, Dell Precision™ workstations, 11th-generation Dell PowerEdge™ servers, and Dell EqualLogic™ PS Series Internet SCSI (iSCSI) storage area network (SAN) arrays. The 11th-generation PowerEdge server family has been optimized for virtualized environments, including increased memory capacity, highly integrated I/O, the advanced Intel® Xeon® processor 5500 series architecture, and an integrated architecture. The EqualLogic PS Series provides a high-performance iSCSI SAN built on fully redundant, hot-swappable hardware, and incorporates automatic load balancing, snapshots, and replication.

By combining centralized control with enhanced mobility, the Dell VRD model enables organizations to simplify management, strengthen security, and capitalize on a growing number of complementary supporting technologies. It can offer numerous advantages for IT groups supporting an increasingly distributed workforce and looking to simplify client management tasks. Storing and managing virtualized desktops on the server helps avoid the need to provision and manage individual client devices. Basic management tasks such as patches, upgrades, and support can be handled quickly and efficiently by centrally storing applications and data. In addition, because virtual desktops are centrally located, they can be quickly backed up and recovered—helping

to accelerate recovery time and enhance business continuity.

ADDRESSING CLIENT MANAGEMENT CHALLENGES

The Dell VRD architecture is designed to effectively and efficiently address many of the key client management challenges that organizations face, including hardware transition complexity, image management, security, and regulatory compliance.

Easing the impact of hardware refresh cycles

Client hardware changes can be difficult on both end users and IT groups: user productivity typically suffers until the replacement system can be personalized, and help-desk support can be a drain on IT resources. An immediate advantage of moving to the Dell VRD approach is that the infrastructure can be upgraded independently of the client image, helping minimize user disruption. Users can still benefit from hardware performance enhancements, but the image and familiar computing experience remain the same.

This approach can also benefit OS transitions, including migrations to the Microsoft® Windows® 7 OS. Updates can be applied easily in the data center, and users can be migrated without forced changes to their desktop hardware or interruptions in their workflow. If a problem does occur, IT organizations can promptly reset users to their previous OS environments until the problem is resolved. The centralized environment allows alternative application delivery methods to be created for applications that may still require a legacy OS to run.

Streamlining image management

Many IT groups struggle with image management when traditional PCs are refreshed. An administrator must open up the OS, insert new drivers, close the OS, and test to make sure that the drivers have not broken an application requirement or a linkage. IT staff must also manage interactions among applications as images and clients change. In a large organization with multiple ongoing refresh cycles, administrators may need to constantly validate and revalidate images to help avoid unintended interactions or impact on applications.

The Dell VRD approach helps save time and effort because the image does not change when the underlying hardware changes, and the drivers for each client are separate from the OS. Also, most applications can be virtualized, helping reduce dependencies on the base OS and allowing added flexibility. Using virtualization to decouple images from hardware helps to simplify the way an organization manages images, streamline the process of refreshing the computing environment, and reduce the IT workload associated with change management.

Helping ensure data security and regulatory compliance

Every device that stores information also carries the risk of loss, theft, and corruption of critical data. Organizations also face increasingly stringent regulatory requirements related to data security. These requirements can be particularly difficult to address when the client data and context are located in the field, where mobile devices are more likely to be lost or stolen and getting mobile users back up and running can be more time-consuming than for users closer to IT resources.

By centralizing data on servers rather than spreading it across individual desktops, the Dell Flexible Computing framework helps guard against data loss from unauthorized access, malicious attack, failed PC hard drives, negligent employee behavior, and noncompliance with organizational or regulatory policies. Using a Dell Flexible Computing Solution with virtual desktops, IT staff can manage the remote client data and context internally, helping enhance security and ensure regulatory compliance. User productivity benefits because when a device is lost, IT staff can quickly provision replacement hardware with the same information.

BOLSTERING THE VIRTUAL DESKTOP APPROACH

Several key technology advances—including enhanced communications protocols, processors, and management tools—help reinforce the Dell VRD approach to client management. For example, recent

THE PC-OVER-IP DIFFERENCE

The Dell Flexible Computing framework supports Teradici PC-over-IP technology, which enables a high-quality virtual client experience. The PC-over-IP display protocol is designed specifically to deliver virtual desktops efficiently over the network by optimizing high-latency and low-bandwidth connections. Key advantages include the following:

- Consistent, high-performance end-user desktop delivery over local area networks (LANs) or wide area networks (WANs)
- Virtual printing, multimedia redirect, USB redirect, and multi-monitor configuration support
- Desktop access from a wide array of devices, providing increased availability
- A single interface to connect to multiple resources for enhanced user productivity
- VMware ThinApp application virtualization enabling agentless deployment, which allows users to install applications on locked-down PCs

The PC-over-IP protocol compresses, encrypts, and encodes the entire virtual desktop at the data center and transmits it "pixels only" across a standard IP network to enabled client devices.

enhanced processor architectures such as the Intel Xeon processor 5500 series in 11th-generation PowerEdge servers can help boost user density on physical servers, which can often drive down the overall cost of virtualized desktops. Technologies such as the Teradici PC-over-IP protocol, composite images, and client hypervisors, meanwhile, can help organizations meet the challenges of delivering client desktops wherever and whenever users need it.

Boosting productivity with PC-over-IP technology

To keep workers productive and avoid unnecessary support costs, the virtual desktop infrastructure should deliver a familiar, seamless experience that meets or exceeds the performance users have come to expect from a physical PC. Regardless of usage scenario or client device, delivering a high-quality user experience—with responsive application performance, smooth video, and quick downloads—is essential to the success of a virtual desktop implementation.

A significant advance in this area is the introduction of Teradici PC-over-IP technology as a virtual remote desktop protocol (see the "The PC-over-IP difference" sidebar in this article). PC-over-IP technology contributes to a successful deployment by offering a cost-effective, scalable approach to client computing that resembles the traditional desktop computing model. For example, when users move a mouse or type an entry into a search bar, they can see the results immediately. The protocol also supports rich functionality like streaming video and high-resolution graphics and works well over both local area networks (LANs) and wide area networks (WANs), using bandwidth similar to what is consumed across a normal cable modem.

Building composite images for simplified management

Virtualization software partners are enhancing the Dell VRD approach by incorporating composite image capability. To create a composite image, Dell recommends separating the base OS from the applications, user profile, and data by using application- and profile-virtualization tools such as those found in VMware View and Citrix XenDesktop™ virtualization software. Composite imaging dynamically builds user images from individually managed OS, application, user profile, and data components, allowing IT staff to manage the components separately while still providing employees with a familiar, individualized desktop environment. VMware View 4 with View Composer enables building out the composite image by virtualizing the OS away from the applications and user settings; Citrix XenDesktop 4 desktop virtualization software with the Citrix Provisioning Server™ for Desktops stack provides composite image capabilities as well.

Using client hypervisors to run virtual clients unconnected

Client hypervisors, announced by several vendors (including VMware and Citrix) and expected to be available in 2010, can further enhance the use and management of virtual images. The client hypervisor is designed to deploy virtual images onto physical hardware and then run the PCs disconnected from the network. To run a virtual client today, the device must be connected to the network, and performance depends largely on the strength and speed of the network connection. With a client hypervisor, users can check out a virtual image onto a laptop, then disconnect and use the hardware and image in the field even where no connectivity is available.

In this way, client hypervisors can help organizations to maintain user productivity and significantly increase IT efficiency. The image remains present in the data center, is managed as a single composite image, and is built dynamically for individual users during checkout. The build process applies

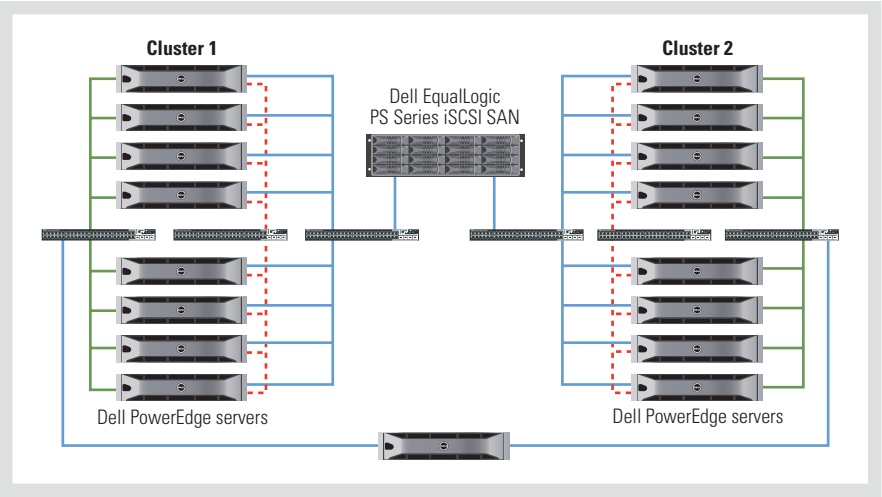

Figure 2. *Example architecture for a virtual desktop environment based on the Dell Flexible Computing framework*

the appropriate drivers and user settings for each virtual client, but those settings are unmanaged blocks that do not require administrator time and effort. IT staff can manage and run the same image on a server, desktop, or laptop regardless of hardware differences.

Client hypervisor technology also enables remote users to access local storage as they would with a traditional PC, and to roam freely even as they enjoy familiar desktop operating systems and environments. When users reconnect to the network, their changes are copied to the server, and the integrity of the data is preserved.

EASING THE TRANSITION TO VIRTUAL DESKTOPS

Many organizations are taking advantage of Dell implementation services and standards-based reference architectures (see Figure 2) to facilitate their transition to virtual client desktops and begin gaining the myriad benefits they can provide.[1] Dell Infrastructure Consulting Services offers end-to-end Dell Flexible Computing infrastructure with a single point of contact for hardware, software, services, and ongoing support. Dell consultants can work with an organization to gain an understanding of specific business and organizational objectives, and then develop a virtual client deployment strategy that is flexible enough to adapt to current environments and structured to scale to future requirements.

Dell Flexible Computing services match individualized profiles to Dell hardware configurations, helping organizations meet diverse end-user computing requirements. The Dell End User Profiling Assessment service helps define user groups and workloads before implementing a virtual desktop infrastructure. The profiling utilizes online surveys and remote auditing of end-user devices to gather data. Dell consultants can then adapt reference architectures to the specific environment and assist in sizing the solution based on desktop configurations and user workload profiles.

Understanding how different applications affect physical processor, memory, network, and storage resources is key to sizing the virtual desktop servers and storage. Other factors to consider include storage and network virtualization overhead, remote connection overhead, and sufficient headroom allowance to account for usage spikes at busy times of the workday. As a final step, Dell consultants can deploy the configuration in a test environment to validate performance.

CREATING A FLEXIBLE FRAMEWORK FOR EFFICIENT CLIENT COMPUTING

In many ways, the ultimate benchmark for technology leaders is how cost-effectively the IT infrastructure advances core business and organizational objectives. The Dell Flexible Computing framework enhances enterprise efficiency by helping organizations to standardize, simplify, and automate the management of virtual clients (see the "Kick business innovation into high gear with an Efficient Enterprise" sidebar in this article). By shifting the focus from physical systems to centralized IT control of end-user digital identities, organizations can simplify hardware transitions, image management, data security, and regulatory compliance, while extending product life cycles and significantly enhancing workforce productivity.

Roberto Ayala is a solutions marketing manager for the Dell Business Client Group, where he develops Flexible Computing outbound messaging.

Juan Vega is a product strategist for the Dell Software and Solutions Group, where he is a leader in developing client virtualization strategies.

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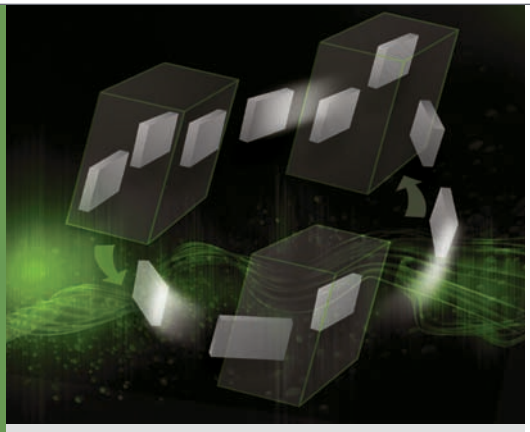
[1] To read about how Montgomery Independent School District and the Dutch province of South Holland have benefited from Dell Flexible Computing Solutions and Dell consulting expertise, see "Streaming Education," in *Dell Power Solutions*, 2010 Issue 1, DELL.COM/Downloads/Global/Power/ps1q10-20100384-MISD.pdf; and "A Thinner, Greener Solution," in *Dell Power Solutions*, 2010 Issue 1, DELL.COM/Downloads/Global/Power/ps1q10-20100385-Holland.pdf.



SHIFTING TO A VIRTUAL DESKTOP PARADIGM WITH DELL FLEXIBLE COMPUTING AND CITRIX XENDESKTOP

By Calvin Hsu
Roberto Ayala

Enterprises are poised for exploring alternatives to traditional desktop computing models. Integrating Citrix® XenDesktop™ 4 desktop virtualization software within the Dell™ Flexible Computing framework is a cost-efficient way to enhance security, streamline management, and boost user productivity, while providing the flexibility to support a comprehensive array of business requirements.

As enterprises consider migrating client systems to the Microsoft® Windows® 7 OS, many are reevaluating how their IT groups provision, manage, and support the desktop environment. IT administrators are ready for fundamental changes that can address ongoing challenges. They need ways to boost user mobility and work flexibly while also helping to tighten enterprise security, simplify management, and reduce the overall cost of owning and operating client systems. Virtualizing the desktop environment with Citrix XenDesktop 4 software, a Dell hardware infrastructure, and Dell services helps organizations address desktop challenges and accommodate a broad range of business requirements.

MANAGING TODAY'S DESKTOP ENVIRONMENTS

IT departments today face an array of challenges in providing, managing, and supporting desktop environments across the enterprise. Security is a top concern. IT groups need to ensure that enterprise data remains protected, especially as mobile computing increases: the loss of a laptop or memory stick must not compromise sensitive data, intellectual property, or customer information.

Simplifying management is another high priority—managing a complex desktop environment is costly, and pulls administrators away from strategic projects. IT groups need to simplify key management tasks, including the provisioning of computing environments for new employees, contractors, or acquired business units; the deployment of updates, patches, and upgrades; and the resolution of software-related problems experienced by employees.

IT groups also must implement desktop strategies that can let employees be productive virtually anytime, anywhere. Allowing users to work on a wide range of client devices can help. Today's increasingly tech-savvy workers no longer want to be tethered to a single desktop or laptop—they want the flexibility to work from an array of systems, including their own personal computers. IT administrators need ways to support bring-your-own-computer (BYOC) models and allow employees to use systems that are outside of company standards.

Sustaining worker productivity is an additional challenge. IT groups need ways to make sure work does not stop when an individual computer needs repair. To help ensure business continuity in the event of a natural disaster or disease outbreak, IT groups also need strategies for keeping employees working without having to come into the office.

And finally, to help reduce the overall cost of owning and operating the desktop environment

across the enterprise, IT groups must find cost-effective solutions for all these challenges.

ADDRESSING CHALLENGES WITH CITRIX XENDESKTOP

Virtualizing the desktop with Citrix XenDesktop 4 software helps organizations address these challenges. XenDesktop is a desktop virtualization solution that delivers Microsoft Windows–based desktops as an on-demand service to employees, wherever they may be working. Unlike other solutions, XenDesktop provides flexibility for using multiple models for desktop delivery so IT groups can tailor solutions for a broad range of user scenarios.

Simplifying management

By relocating the OS, applications, and user settings from client systems to the data center, XenDesktop helps centralize desktop management. Administrators can avoid making time-consuming desk-side support visits to resolve software-related issues—fixes can instead be implemented from the data center. Centralized desktop management can also help accelerate provisioning and implementation of updates and patches.

XenDesktop offers a single-image management approach to desktop virtualization that helps further simplify management compared with the typical virtual desktop infrastructure (VDI) model. VDI without single-image management requires IT groups to keep a unique image for each individual user, much as they would in a traditional distributed PC management model. If administrators need to make changes to the OS or an application, they must go through the time-consuming and potentially error-prone process of deploying updates to each user image. In addition, storing numerous individual user images across the enterprise (each with an OS, multiple applications, and user information) can require a tremendous amount of storage capacity and can increase IT management complexity.

> **"XenDesktop helps tighten desktop security by enabling IT staff to ensure that critical data—including e-mail messages and documents—does not leave the secure data center, and keeping users from downloading it to potentially vulnerable client systems."**

With the single-image approach, IT administrators manage just one OS image and one image for each application used in the enterprise. Only the user's data—such as application preferences, templates, and documents—are stored on an individual basis.

The Citrix FlexCast™ delivery technology available with XenDesktop dynamically assembles and delivers each user's complete desktop—with OS, applications, and all preferences—on demand to the end user's device, whether it is a desktop, laptop, or mobile device (see Figure 1). FlexCast makes it possible for users and IT groups to tailor desktops to the needs of individual users without the IT group having to store and manage numerous individual user images in the data center.

The single-image approach used by XenDesktop has several additional IT advantages. First, administrators need to apply software updates, upgrades, and patches only once; changes are then immediately available to all users. Second, each desktop component is isolated from the others in the data center, helping administrators to avoid the compatibility issues that are often the cause of user problems in traditional desktop environments.

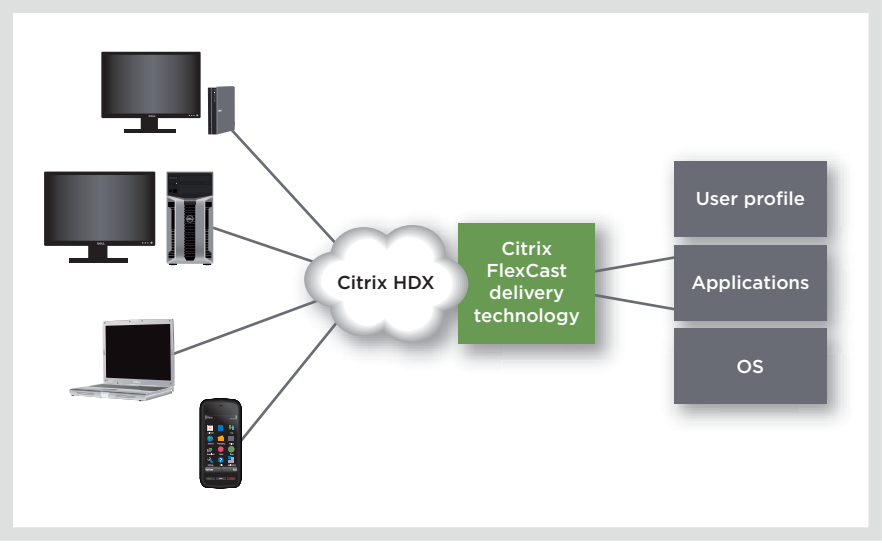


Figure 1. *Citrix FlexCast provides multiple delivery models to accommodate a wide range of user needs and environments*

Tightening security

XenDesktop helps tighten desktop security by enabling IT staff to ensure that critical data—including e-mail messages and documents—does not leave the secure data center, and keeping users from downloading it to potentially

vulnerable client systems. Because employees can access the same virtual desktop and applications from virtually any computer, they no longer need to store data on their laptops or use memory sticks, e-mail, or optical media to transfer files from one computer to another. If a laptop is lost or stolen, this approach helps prevent unauthorized users from accessing sensitive information.

To provide additional security, XenDesktop enables administrators to set policies that make access conditional on location or network type. Administrators can allow employees to access their desktop environments when they are outside the office, but restrict access to the most sensitive data to office use only. When an employee leaves the company, access privileges can be removed immediately, leaving no data exposed.

Enhancing user productivity

XenDesktop enhances user productivity by giving employees the flexibility to access their desktop environments from virtually any device, ranging from office PCs to hotel kiosks to smartphones. Enterprises can even allow employees to buy and use their own computers for business use. Because the desktop environment is managed centrally, IT groups do not have to worry about supporting a myriad of hardware-dependent images. And importantly, productivity need not come to a halt if an employee's computer has problems: when one computer requires repair, employees can quickly move to another without needing to restore data and configurations, minimizing loss of time and productivity.

Reducing costs

By simplifying desktop management and support, and by enhancing worker productivity, XenDesktop helps organizations gain additional value from existing resources. At the same time, it can help reduce the total cost of owning and operating the desktop environment across the enterprise. By hosting operating systems and applications on data center servers rather than client systems, enterprises can extend the life span of systems and avoid the constant need to refresh hardware to keep up with new OS and application requirements. IT groups can reinvest those savings into data center enhancements that can play a strong role in achieving the goals of the organization.

> **"XenDesktop enhances user productivity by giving employees the flexibility to access their desktop environments from virtually any device."**

Enterprises also gain the flexibility to choose the best mix of client systems for their users—including cost-effective thin clients—without adding management complexity. In addition, they can cut application licensing costs by efficiently delivering applications only to those that truly need them.

INCREASING AGILITY AND PERFORMANCE

The one-size-fits-all approach taken with other desktop virtualization solutions can restrict computing flexibility and limit return on investment (ROI). Citrix XenDesktop with FlexCast allows IT groups to offer multiple desktop delivery models to accommodate a wide variety of user and enterprise needs, and can easily change the mix of delivery methods as those needs change:

- **Local streamed desktop:** Supported by the Dell On-Demand Desktop Streaming™ (ODDS) solution, this model gives users access to a centralized virtual desktop that is installed in the data center but run on client systems. Designed for local area networks (LANs) with standardized rich-computing endpoints, this model can be a good approach for health care organizations, government agencies, and educational settings.
- **Hosted virtual machine–based desktop (VDI):** This model, offered through the Dell Virtual Remote Desktop (VRD) solution, accommodates users over LANs or wide area networks (WANs) who have average processing needs but require personalized environments. These may include knowledge workers such as analysts, doctors, managers, application developers, professors, and so on. The virtual desktop is both hosted and run in the data center, with each host server potentially able to support up to 130 virtual desktops.[1] Virtualization software emulates a local desktop-computing experience.
- **Hosted shared desktop:** Designed for task workers, such as call center employees, who do not need a customized environment, this delivery model hosts the desktop on a server running a Microsoft Windows Server® OS and shares that desktop among multiple users in their own unique sessions.
- **Hosted PC desktop:** This model was designed for users who need additional processor, memory, and graphics processing unit (GPU) resources, such as engineers or designers running computer-aided design (CAD), computer-aided manufacturing (CAM), or graphic information system (GIS) applications. With this model, users run applications on a hosted workstation. While providing the benefits of centralization, this model can deliver the

[1] Based on Citrix lab tests using XenDesktop 4 with XenServer™ 5.5 software on a Dell PowerEdge R710 server configured with two quad-core Intel® Xeon® X5570 processors at 2.93 GHz and 72 GB of RAM. For details, see "Citrix XenDesktop 4 Single Server Scalability Test Results on Citrix XenServer 5.5," by Citrix Systems, Inc., February 2010, available at support.citrix.com/article/CTX124086.

dedicated processing power required for each user by hosting only one desktop on each workstation.

- **Virtual applications on installed operating systems:** An ideal starting point for many organizations, this model enables mobile users to run applications offline. The applications are managed and served from the data center, but run on the local device. Using this model, organizations can take advantage of some of the ROI and management advantages of centralization for specific applications with minimal setup costs.
- **Local virtual machine–based desktop:** This emerging model uses client-based hypervisors to support mobile users who need to run their virtual desktops offline. When they reconnect to the network, changes to the virtual desktop image implemented in the data center can be synchronized automatically on their local systems.

Although the potential for end-user performance issues may have been a stumbling block for organizations and users adopting virtual desktop solutions in the past, the Citrix HDX™ technologies in XenDesktop help overcome network bandwidth and latency limitations and deliver a robust user experience. HDX MediaStream provides server and client optimizations that can significantly enhance performance of Adobe® Flash, Microsoft Windows Media® Video (WMV), Audio Video Interleave (AVI), and other multimedia file types. HDX RealTime technology enhances audio and video performance for real-time interactions through voice-over-IP (VoIP) phone or videoconferencing. HDX 3D for Professional Graphics applies compression technology to help deliver outstanding performance for CAD, CAM, and engineering applications within the virtual desktop model. Additional HDX technologies facilitate plug-and-play use of peripherals, enable local caching to conserve bandwidth in branch office settings, and facilitate use of virtual desktops even in high-latency, low-bandwidth environments.

PROVIDING THE FOUNDATION FOR DELL FLEXIBLE COMPUTING

Integrating Citrix XenDesktop into a Dell infrastructure helps enterprises achieve a robust and reliable environment for desktop virtualization while maximizing computing flexibility for users. Dell offers a wide range of standards-based client systems to accommodate the needs of different types of users and different virtual desktop distribution models. When implementing a XenDesktop environment, many organizations can benefit from the array of Dell laptops and netbooks. Because the OS and applications are managed from the data center, organizations can select multiple Dell system models to help meet the different needs of users without adding management complexity. Using XenDesktop, enterprises can even enable users to select and buy their own preferred Dell models.

In the data center, Dell PowerEdge™ servers offer the processing performance, memory capacity, and reliability to host the XenDesktop environment. Because XenDesktop helps to reduce the amount of storage capacity needed for the desktop environment, organizations can avoid the costs of a massive storage system that might be needed to support a typical VDI environment. Dell EqualLogic™ PS Series Internet SCSI (iSCSI) storage area network (SAN) arrays provide an easy-to-manage storage solution with seamless, nondisruptive scalability and enterprise-class performance and reliability to support virtual desktop environments.

Dell Flexible Computing Solutions help organizations find the appropriate solution for their desktop environments, whether it involves a virtual desktop or a more traditional environment. Dell consultants from Dell Services work to understand an organization's challenges, specific use cases, and goals. Dell consultants then provide effective design, implementation, and support services for an enhanced desktop environment. In some cases, selecting the Dell Managed Virtual Desktop service, hosted either by the organization or by Dell, can be an optimized way for organizations to cost-effectively capitalize on the advantages of desktop virtualization without the risks or burdens of building and managing their own solutions.

DEPLOYING DESKTOP VIRTUALIZATION TO SUPPORT FLEXIBLE COMPUTING

As enterprises coalesce plans for migrating desktops and laptops to the Microsoft Windows 7 OS, many are reevaluating how client systems are provisioned, managed, and supported. Desktop virtualization with Citrix XenDesktop 4 helps enterprises simplify the move to Windows 7 and increase the efficiency of ongoing management. At the same time, deploying a virtual desktop environment with XenDesktop helps tighten security, reduce costs, and boost user productivity by promoting a flexible computing model that lets employees access their desktop environments from virtually any device, anywhere in the world.

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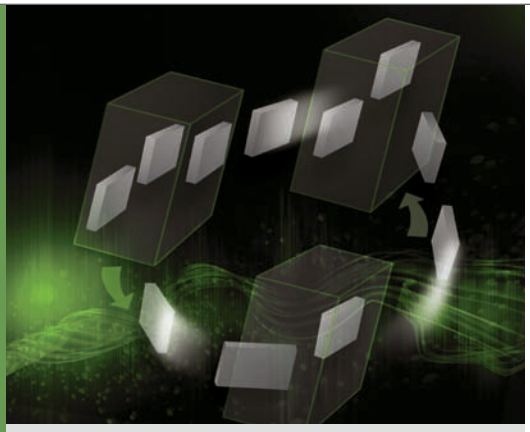

INTEGRATED MANAGEMENT FOR VIRTUALIZED DELL SERVERS USING THE DELL PRO PACK AND MICROSOFT SYSTEM CENTER

By Brent Douglas
Viswanathan Balakrishnan
Saravan Kumar
Tushar Oza
Ravi Kumar Pare
Sridhar Chakravarthy
Amit De

In environments based on Dell™ servers and Microsoft® Hyper-V™ virtualization, the Dell Server Performance and Resource Optimization Management Pack (Dell PRO Pack) provides robust, integrated monitoring and proactive management through Microsoft System Center Operations Manager, System Center Essentials, and System Center Virtual Machine Manager.

With virtualization becoming a standard part of the data center vernacular, the focus for IT administrators is beginning to turn from deploying virtualization to managing virtualization. For all but the smallest virtualization deployments, creating a simple and efficient management infrastructure can be an ongoing challenge.

Virtualization management encompasses the virtual machines (VMs) themselves as well as the hardware platforms on which the hypervisors and associated VMs run. The Microsoft System Center suite includes three products that administrators can use to manage physical and virtualized environments: System Center Operations Manager (SCOM) and System Center Essentials (SCE) for physical environments, and System Center Virtual Machine Manager (SCVMM) for virtualized environments. When combined with Dell OpenManage™ software on Dell hardware platforms, SCOM/SCE and SCVMM can provide comprehensive health monitoring and management functionality for the Microsoft Windows Server® 2008 R2 Hyper-V and Hyper-V Server 2008 R2 software and hardware stack (see Figure 1).

The Dell Server Performance and Resource Optimization Management Pack (Dell PRO Pack) is designed to integrate Dell OpenManage and Dell PRO manageability into SCOM/SCE and SCVMM, providing unified monitoring and proactive management for Dell servers running Hyper-V virtualized workloads. Organizations can use the combination of SCOM/SCE, SCVMM, Dell OpenManage, and the Dell PRO Pack to manage both virtualized workloads on individual servers and clusters of physical hosts, including identifying and implementing appropriate remediation actions following physical hardware events—helping to simplify management and create an environment that can maintain high levels of uptime for VMs, applications, and services during unexpected physical server outages as well as planned data center maintenance windows.

MICROSOFT SYSTEM CENTER INTEGRATION

The Microsoft System Center plug-in architecture enables third parties to develop management packs (MPs) for their own hardware, services, and applications. Dell offers a variety of these plug-ins as part of the Dell OpenManage Integration Suite for Microsoft System Center, available as a software download at no additional cost: Dell MPs enable seamless monitoring of Dell hardware from within SCOM/SCE, while the Dell PRO Pack enables tight integration between physical and virtualized server environments within SCVMM. SCOM/SCE integration with SCVMM enables the Dell PRO Pack to generate PRO Tips, which make recommendations to help administrators with the remediation of hardware events. The Dell PRO Pack can integrate

with SCOM 2007 with Service Pack 1 (SP1), SCOM 2007 R2, SCE 2007 with SP1, SCVMM 2008, and SCVMM 2008 R2.

SCOM/SCE and SCVMM integration is a prerequisite for enabling the PRO Tips feature of the Dell PRO Pack. This connectivity is provided through the Microsoft SCVMM 2008 R2 MP, which links the performance and health monitoring capabilities of SCOM/SCE with the virtualization management capabilities of SCVMM—enabling SCVMM to monitor the health, availability, and performance of Hyper-V host servers and the VMs deployed on those hosts.

After integrating SCOM/SCE with SCVMM, administrators can enable additional PRO functionality for individual host groups and host clusters. They can also configure SCVMM PRO settings to enable PRO features for issues that affect systems throughout the virtualized environment.

DELL PRO REMEDIATION ACTIONS

The Dell PRO Pack extends Dell OpenManage monitoring capabilities for Dell server hardware to virtualized services by continuously monitoring the health of the virtualized infrastructure. The Dell PRO Pack is specifically targeted toward Microsoft Hyper-V hosts providing quick migration (in Microsoft Windows Server 2008) or live migration (in Microsoft Windows Server 2008 R2), based on the support available in the hosted OS. (For further details on supported features, consult the Dell PRO Pack documentation.)

Dell PRO remediation actions are Windows PowerShell™ scripts associated with monitors in SCOM/SCE, and can be run when a monitor transitions to an unhealthy state. SCVMM uses the SCOM/SCE recovery tasks to help resolve problems discovered by the PRO Tips feature. A workflow in the Dell PRO Pack is designed to redirect the Windows PowerShell recovery scripts to always run on the SCOM/SCE server, regardless of the host location where the monitor transitioned to an unhealthy state.

When Dell OpenManage detects a monitored hardware event, the Dell PRO Pack suggests remediation actions (PRO Tips) based on the severity of the event, historical usage, and the health of the Hyper-V hosts in the environment. The Dell PRO Pack incorporates two remediation actions:

- **Restrict:** This action is initiated by Dell OpenManage events with a "warning" severity level. From a device redundancy perspective, all events that indicate a degradation in redundancy are marked for a Restrict action. When this level of event is triggered, the Hyper-V server's hardware health status is reported in SCOM/SCE using Dell OpenManage, and the administrator is prompted to implement a suggested action to prevent new VMs from being placed on the degraded server. This action is suggested to help keep this host from becoming more invested in the overall clustered Hyper-V hosting environment than it already is.
- **Restrict and Migrate:** This action is initiated by Dell OpenManage events with a "critical" severity level. From a device redundancy perspective, all events that indicate loss of redundancy are marked for a Restrict and Migrate action. When this level of event is triggered, the administrator is prompted to implement the suggested actions of marking the server as unavailable for placing any new VMs and, most importantly, migrating all running VMs from the unhealthy host to a healthy host in SCVMM (see Figure 2).

Management software	Managed component
SCOM/SCE	VM applications (through additional SCOM/SCE plug-ins)
SCOM/SCE and SCVMM	VMs and VM operating systems
SCOM/SCE and SCVMM	Physical (host) applications and services, including Hyper-V high-availability features such as failover clustering
SCOM/SCE and SCVMM	Hyper-V hypervisor (through Microsoft SCVMM MP)
SCOM/SCE	Physical server OS (through Dell Server MP)
Dell OpenManage	Physical server, local and direct attach storage, networks, environment (temperatures and fans), processor and memory health, power consumption, and BIOS

More virtual

More physical

Figure 1. *Comprehensive monitoring and management stack for Dell servers running the Microsoft Hyper-V hypervisor*

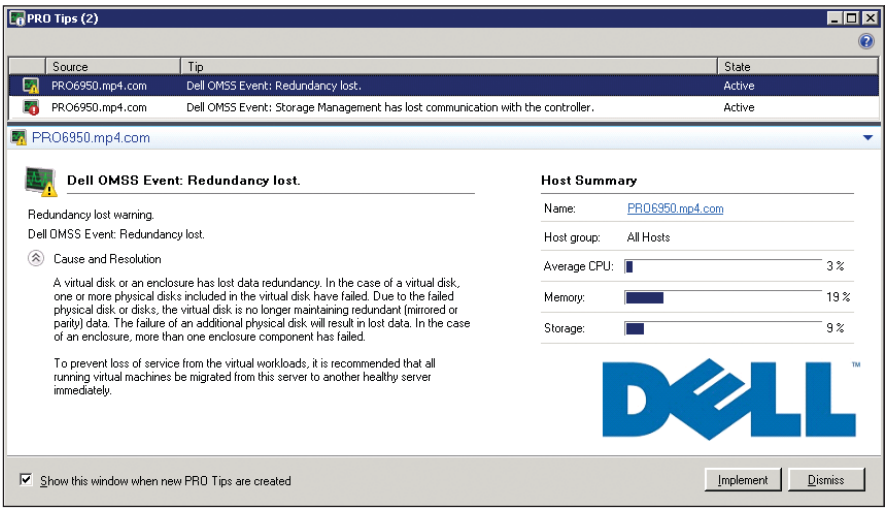

Figure 2. *Dell PRO Pack Restrict and Migrate remediation action following a loss of redundancy*

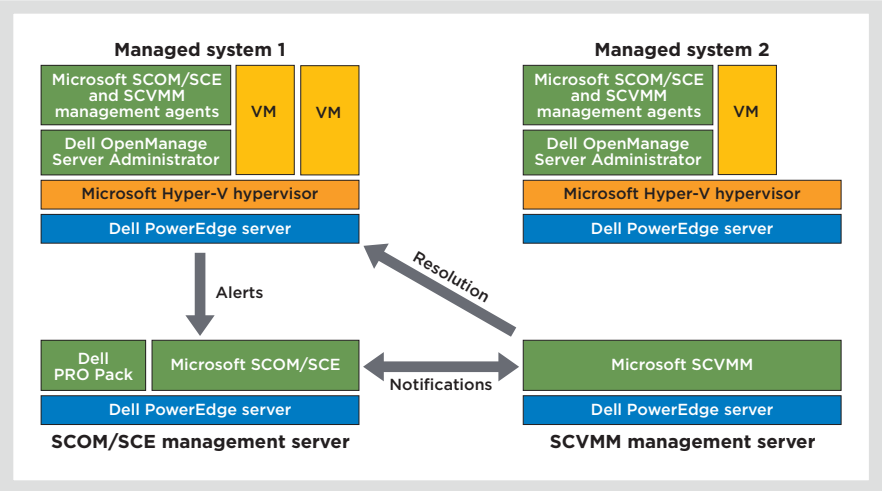

Figure 3. *Dell PRO Pack alert and remediation process*

For a list of monitored events, consult the Dell PRO Pack documentation.

DELL PRO ALERT AND REMEDIATION PROCESS

Figure 3 illustrates the components and process for Dell PRO alerts and remediation. As an example, the following would be a typical process for a Temperature Exceeded the Maximum Failure Threshold event:

1. The Dell OpenManage Server Administrator (OMSA) software installed on the Dell server host determines that an over-temperature condition exists, which is considered a critical event. Both server and storage (OMSS) events are monitored; for a list of monitored events, consult the Dell PRO Pack documentation.
2. OMSA logs an event ID 2102 into the host's system log.
3. The SCOM/SCE agent installed on the Dell server host picks up this event and reports it back to the SCOM/SCE management server.
4. The Dell Server MP picks up the host error generated by OMSA, alerting the administrator to the nature of the issue in SCOM/SCE. At the same time, the Dell PRO Pack directs SCVMM to recommend the Restrict and Migrate remediation action.
5. From the SCVMM console, the administrator implements the suggested action (when the Dell PRO Pack is configured for manual mode, the default setting). The host is made unavailable for further VM placements, and all running VMs are migrated from this server to another healthy server. Administrators can enable auto-implement for specific event-by-event bases using SCOM overrides, or for global and/or per-host bases using SCVMM PRO settings.

By default, the Dell PRO Pack is designed to make aggressive use of the two remediation actions. This approach helps to quickly address server and environmental problems, and to reduce the possibility of a Hyper-V server failure and the loss of its virtualized workload. If these actions are too aggressive or not aggressive enough for a specific environment, administrators can use SCOM/SCE overrides to redefine or disable the actions. A comprehensive list of default actions for supported Dell OpenManage events is included in the Dell PRO Pack documentation, along with override procedures.

PROACTIVE MANAGEMENT FOR VIRTUALIZED DELL SERVERS

Microsoft SCOM/SCE and SCVMM are designed to provide robust control over physical and virtualized hardware. Utilizing the integrated manageability functions provided by the Dell PRO Pack enables administrators to extend this control to Dell servers running Hyper-V virtualized workloads—enabling unified, simplified, proactive management across the virtualized infrastructure while helping maintain uptime for critical systems.

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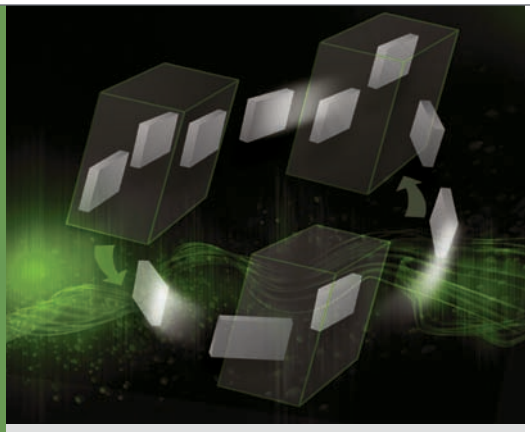

VIRTUAL MACHINE QUEUES: ENHANCED THROUGHPUT FOR MICROSOFT WINDOWS SERVER 2008 R2 HYPER-V

By Ravikanth Chaganti
Barun Chaudhary

The virtual machine queue feature introduced in the Microsoft® Windows Server® 2008 R2 Hyper-V™ platform is designed to offload virtual network processing to physical adapter hardware. Enabling this feature on Dell™ PowerEdge™ servers with supported Intel® adapters can help significantly increase overall throughput while reducing the network processing burden on host servers.

Although consolidating application workloads onto virtual machines (VMs) can help significantly increase server utilization, it also introduces its own specific challenges, including contention for available network bandwidth and other resources. The Microsoft Windows Server 2008 R2 OS introduces several enhancements to Hyper-V designed to address these challenges, one of which is the VM queue (VMQ) feature. This functionality requires support from the underlying network adapter hardware, but as Dell testing shows, enabling the feature can dramatically increase overall throughput for network I/O–intensive workloads while helping reduce the network processing burden on host servers.

VMQ ARCHITECTURE AND FUNCTIONALITY

In previous versions of Hyper-V, the virtual-network-switch implementation processed network traffic between VMs and physical network interface cards (NICs). This processing included classifying and filtering packets based on Media Access Control (MAC) addresses or virtual LAN (VLAN) identifiers as well as routing these packets to the appropriate VM adapter. Because the number of packets being routed by the host server typically increases when VM density rises, so does host processor utilization.

The VMQ feature introduced in Windows Server 2008 R2 Hyper-V is designed to overcome this challenge and enable optimal use of hardware resources. This feature is a silicon-level implementation that works in conjunction with hardware support and includes the intelligence for multiple queue formation (as supported by the specific adapter) and the sorting of packets in the physical NIC. This approach offloads packet sorting and routing from the host processor, helping save processor cycles for other applications. Organizations can deploy this technology using supported Dell PowerEdge platforms with Gigabit Ethernet (GbE) Intel VT quad-port server adapters as well as 10 Gigabit Ethernet (10GbE) Intel XF SR, Intel AT, and Intel DAC server adapters; other upcoming 10GbE Intel adapters are expected to support the feature as well.

Figure 1 shows the VMQ architecture. Without VMQ enabled, the hypervisor must sort and route the packets to the destination VMs, and the incoming packets are copied twice while transmitting from the NIC buffer to the application buffer. With VMQ enabled, multiple queues are formed, with each queue corresponding to a VM; there is also a default queue that routes multicast packets, broadcast packets, and packets without a specified queue. When data packets arrive at the physical NIC, the NIC sorts the packets based on

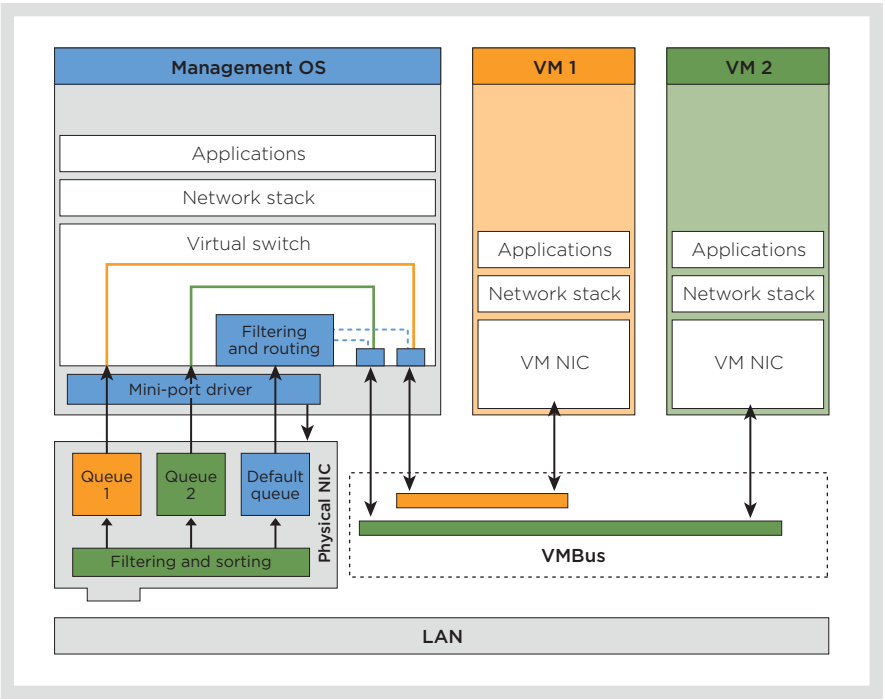

Figure 1. *Microsoft Windows Server 2008 R2 Hyper-V VMQ architecture*

the MAC addresses and VLAN tags of the destination VM and places them in the appropriate receive queues. The virtual network switch then takes the corresponding packets in the queue to the VMs.[1]

VMQ CONFIGURATION

The Intel network adapter drivers for Dell servers disable VMQ by default. To enable VMQ, administrators should enable VMQ support on the physical network adapter and on the virtual switch. There is no configuration required inside the guest OS to enable this feature.

Enabling VMQ support for the virtual switch first requires modifying the registry:

- For GbE adapters, administrators can perform this step by adding a `BelowTenGigVmqEnabled` entry under HKLM\SYSTEM\CurrentControlSet\Services\VMSMP\Parameters and setting its value to `1`.
- For 10GbE adapters, they would add a `TenGigVmqEnabled` entry in the same location, also with its value set to `1`.

Next, to enable the VMQ feature on the physical network adapter, administrators can launch the Device Manager tool, expand the "Network adapters" section, right-click on the adapter that supports the VMQ feature, and select "Properties." In the properties window, they can then select the Virtual Machine Queues property, set the value to "Enabled" (see Figure 2), click the OK button, and close Device Manager.

Administrators should note that they must perform these steps in the order described.

When using Microsoft System Center Virtual Machine Manager (SCVMM) 2008 R2 to manage Hyper-V VMs, administrators can enable or disable the VMQ feature for a VM network adapter by selecting or unselecting the Enable Virtual Network Optimizations check box in the VM properties window. This option is available only when using SCVMM 2008 R2 with Windows Server 2008 R2 Hyper-V VMs.

[1] For more information on the VMQ feature in Microsoft Hyper-V, visit msdn.microsoft.com/en-us/library/dd568132.aspx. For more information on this feature in Intel server adapters, visit www.intel.com/network/connectivity/vtc_vmdq.htm.

NETWORK THROUGHPUT FOR VIRTUALIZED FILE SERVERS

Network I/O–intensive workloads such as file servers can directly benefit from using the VMQ feature on Windows Server 2008 R2 Hyper-V host servers. To demonstrate this enhancement, in August 2009 Dell engineers performed several tests using custom scripts to stress a file server with and without the VMQ feature enabled, and measured the resulting network throughput and file copy times.

The test environment consisted of one file server and three client servers. The file server was a Dell PowerEdge R610 configured with one quad-core Intel Xeon® E5530 processor at 2.4 GHz, 8 GB of RAM, a 10GbE Intel AT server adapter, four GbE Broadcom LAN on Motherboards (LOMs), and the Windows Server 2008 R2 Datacenter OS. The three clients were PowerEdge SC1435 servers, each configured with one quad-core AMD Opteron™ 2350 processor at 2.0 GHz, 4 GB of RAM, two GbE Broadcom LOMs, and the 32-bit version of the Microsoft Windows Vista® OS with Service Pack 1 (SP1).

The custom scripts were designed to copy large numbers of mixed-size files (varying from a few kilobytes to approximately 6 GB) from the clients to the VMs. The VMs were stored on an external Dell PowerVault™ MD3000i Internet SCSI

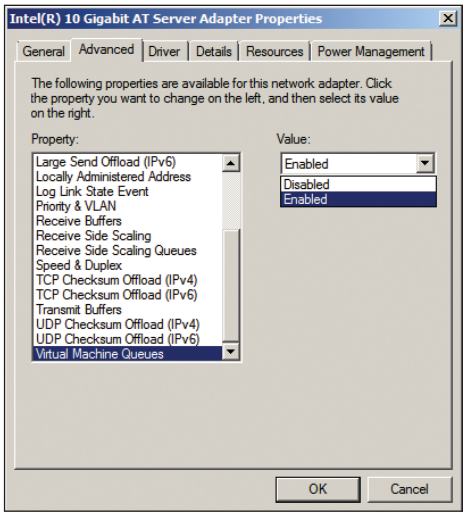

Figure 2. *Adapter properties in the Microsoft Windows Server 2008 R2 Device Manager tool*

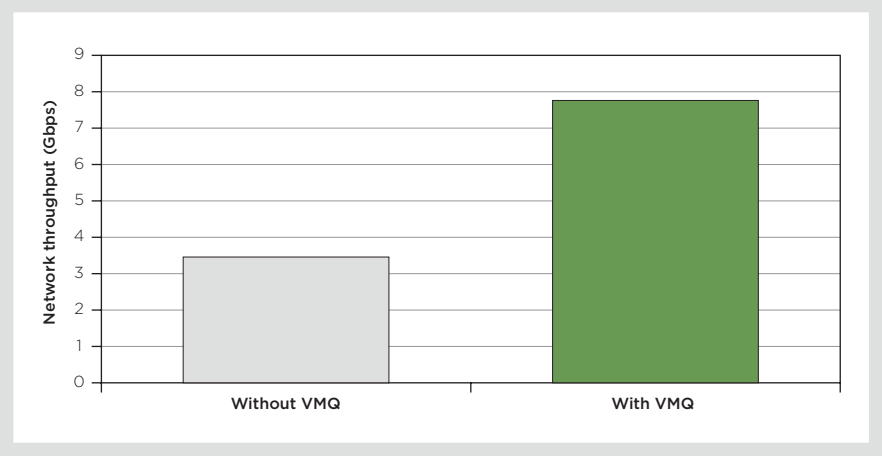

Figure 3. *Network throughput with and without the VMQ feature enabled*

(iSCSI) storage array, and connected to a virtual switch configured on the 10GbE Intel AT adapter; the clients connected to GbE ports on the same switch as the VMs. The iSCSI logical units (LUNs) were directly mapped into the guest OS using the Microsoft iSCSI Software Initiator to help ensure that the disk I/O load translated to a network I/O load, and therefore resulted in an increased load on the virtual network.

These tests showed that enabling the VMQ feature reduced the average number of hardware interrupts to the management OS—translating to reduced processor utilization on the host server—and helped increase overall network throughput. Figure 3 shows the network throughput with and without the VMQ feature enabled: enabling the VMQ feature with the 10GbE network adapter more than doubled the throughput, to approximately 7.8 Gbps.

The increase in overall network throughput with the VMQ feature enabled also led to reduced copy times between the test clients and the VMs. Figure 4 shows these copy times with and without the VMQ feature enabled: enabling the feature reduced the times by more than 60 percent. These tests also demonstrate the enhanced file server application throughput when using VMQ-enabled virtual switch ports.

ENHANCED PERFORMANCE FOR VIRTUALIZED ENVIRONMENTS

Dell engineering teams worked with Microsoft and Intel from the early stages of Windows Server 2008 R2 development to validate its enhanced Hyper-V functionality, and a broad selection of Dell PowerEdge server models support the GbE and 10GbE Intel adapters with the VMQ feature. Although GbE network adapters do support VMQs, best practices recommend using 10GbE network adapters to help maximize the advantages of the feature. For environments with supported hardware, enabling the VMQ feature can help significantly increase throughput for network I/O–intensive workloads such as file services running inside a VM while also helping to reduce the processing burden on host servers.

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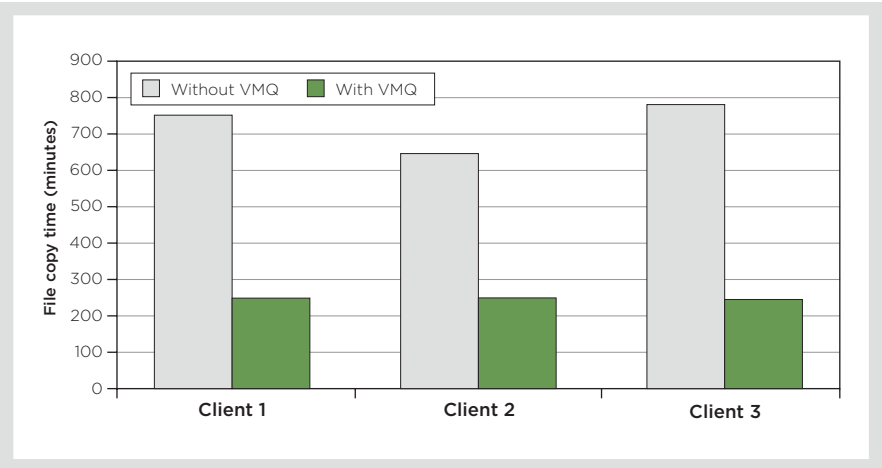

Figure 4. *File copy times with and without the VMQ feature enabled*

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INVESTING IN PRODUCTIVITY

Refreshing legacy hardware, renewing existing systems with enhanced functionality, and redeploying systems for new purposes advances enterprise efficiency and helps organizations get the most out of their IT investments.

Managing a fleet of desktops, laptops, and workstations across an enterprise presents major challenges. What are the best ways to simplify IT management, enhance security, and boost employee productivity? What changes might help reduce energy use and ensure environmental sustainability? How can an organization make the most of its investments in client systems throughout their life spans?

The three key strategies of refreshing, renewing, and redeploying can help organizations address these daily challenges. By refreshing legacy client systems with latest-generation hardware, employees and IT staff alike can gain the productivity, security, and efficiency benefits of advanced features and technologies. And by renewing existing systems with updated software tools or hardware components, or redeploying these systems for new purposes, enterprises can extract maximum value from the investments they have already made.

REFRESHING LEGACY HARDWARE

In many cases, refreshing desktops, laptops, and workstations with systems equipped with the latest technologies offers the fastest and most effective way to maximize efficiency and productivity. Deploying latest-generation systems in place of aging hardware can offer hardware and software tools to help simplify systems management, tighten security, increase productivity, and improve energy efficiency, while effective life cycle management offers opportunities to reduce costs and potentially subsidize the investment in new equipment:

- **Systems management:** Client systems that incorporate the latest hardware and software management tools can dramatically reduce the time that IT staff members spend on routine administration—enabling them to focus instead on strategic priorities. For example, leveraging Intel® vPro™ technology in latest-generation systems can simplify remote management of an entire fleet of PCs, enabling IT staff to push software updates, diagnose software problems, track assets, enhance security, and power down systems, all from a centralized location.
- **Security:** Advances in client security technologies over the past few years can offer sophisticated protection for sensitive enterprise data. Key features in Dell™ Latitude™ E-Family laptops, for example—including integrated fingerprint readers, facial recognition technology, contactless smart card readers, and hardware-based Trusted Platform Module (TPM) and Dell ControlVault™ credential management—offer strong protection for company networks and data. Using self-encrypting drives helps make it easy to keep information safe even if a system is lost or stolen.
- **End-user productivity:** Refreshing client systems also helps improve employee productivity. Powerful multi-core processors and increased memory capacities facilitate multitasking and increased mobility by enabling users to take advantage of processor-intensive voice over IP (VoIP) and Web conferencing software. Systems with enhanced battery life and software utilities

such as Dell ControlPoint enable employees to stay productive while traveling and help simplify power, security, and connectivity functions. And moving to latest-generation client systems also helps smooth transitions to the latest software and operating systems—including the Microsoft® Windows® 7 OS—for both end users and IT staff.

- **Energy efficiency and environmental sustainability:** Latest-generation hardware can offer significant savings on energy costs while enhancing environmental sustainability. To help reduce the environmental impact of refreshes, organizations should work with vendors that use eco-friendly packaging, offer carbon offsets, and comply with environmental standards. Systems that meet U.S. ENERGY STAR program requirements are designed for efficient energy use, while systems with Intel vPro technology enable IT administrators to power down clients remotely to help cut costs. Programs such as the Dell "Plant a Tree for Me" and "Plant a Forest for Me" initiatives, meanwhile, help offset IT-related carbon emissions when purchasing hardware.
- **Life cycle management:** Organizations can help reduce the net costs of refreshing client systems and further reduce the environmental impact of IT through effective life cycle management. Programs such as Dell Asset Recovery Services can resell components and provide appropriate recycling and disposal of remaining materials, helping avoid the need to send computers to a landfill and retaining some of the value of legacy equipment—savings that can then help subsidize the costs of updated systems. And frequently refreshing systems can actually help maximize the value of asset recovery.

RENEWING AND REDEPLOYING EXISTING SYSTEMS

Refreshing client hardware to capitalize on latest-generation technologies can offer substantial benefits—but it is not necessarily the whole story. Renewing and redeploying systems can help maximize the return from existing investments across these same five key areas:

- **Systems management:** Organizations currently relying on multiple legacy management tools should consider replacing them with a centralized, integrated console. This approach helps to simplify IT monitoring and maintenance tasks, eliminate administrative overhead, and enable IT staff to spend their time on more important tasks than administering their management tools.
- **Security:** Updating hardware with advanced authentication technologies helps tighten security for existing systems. Organizations can integrate USB-connected contactless card readers or fingerprint readers for simple user authentication, or add Webcams to desktops for authentication through facial recognition. To help prevent the theft of components or entire systems, they can install security locks and management software that monitors chassis intrusion.
- **End-user productivity:** Adding memory to legacy client systems is often an easy and effective way to enhance worker productivity, providing a much-needed performance boost for employees who use memory-intensive applications or run many applications simultaneously. Upgrading software or installing an OS upgrade such as Windows 7 offers another relatively simple way to revitalize systems. Hardware upgrades can help as well: replacing laptop batteries or providing broadband cards, for example, can significantly enhance mobile productivity.
- **Energy efficiency and environmental sustainability:** Even without purchasing updated systems, organizations can reduce the energy costs and the environmental impact of running a fleet of client systems. Conducting energy assessments and implementing monitoring software helps pinpoint simple changes for reducing energy use. Using management capabilities that let IT staff power down systems at night can also help save energy and cut costs.
- **Life cycle management:** Renewing client systems and redeploying systems for new uses helps extend their useful lives. By repurposing legacy desktops and laptops as thin clients, for example, organizations can give employees access to up-to-date applications through a software-as-a-service (SaaS) model without needing the latest processors or the largest hard drives. Similarly, extending warranty and support contracts helps ensure continued functionality, adding value to the renewed and redeployed systems. Implementing tools that let IT staff track hardware and software assets as well as upcoming changes to product lines can help monitor usage of existing systems while planning for the next refresh cycle.

FINDING THE RIGHT COMBINATION

Refreshing, renewing, and redeploying are not mutually exclusive—organizations might, for example, choose to refresh laptops, renew desktops and workstations with updated hardware or software, and redeploy older laptops as thin clients. Finding the right combination of these three strategies can help enterprises address ongoing challenges and make the most of their IT investments.

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www.dellenterprise.com/goto/client/client-landing.aspx

INTRODUCING THE DELL OPTIPLEX XE: PURPOSE-BUILT FOR DEMANDING ENVIRONMENTS

Designed with the flexibility to meet exacting requirements for embedded systems in a wide range of industry solutions, Dell™ OptiPlex™ XE platforms offer long-term stability, remote manageability, and robust purpose-built features. In addition, Dell OEM Solutions experts provide a comprehensive set of services that help reduce time to market, optimize operations, and enhance business agility.

Regardless of the specific industries they serve, original equipment manufacturers (OEMs) often need system capabilities that reach beyond standard PC offerings. The key to success is having the built-in capability to meet diverse application requirements—whether the embedded solution is ultimately deployed in medical devices, industrial automation equipment, security and surveillance systems, kiosks, gaming systems, point-of-sale terminals, or any of countless other embedded environments. Hardware vendors that provide comprehensive service and support options help OEMs stay focused on competitive product innovations. By offering leading-edge technology with platform life cycle support and change management services, Dell helps ensure that embedded solutions deliver long-term stability, streamlined manageability, and purpose-built features designed for challenging physical environments.

ADDRESSING COMPLEX SUPPORT CHALLENGES

Some OEMs build embedded systems in-house or turn to off-the-shelf PCs. However, these approaches can result in a frequent churn of hardware components that adds costs and inefficiencies as OEMs recertify parts, modify existing software, and support a wide variety of hardware configurations. Some medical devices, for example, must undergo a long and stringent U.S. Food and Drug Administration (FDA) recertification process when components change. OEMs need systems with long life cycles, and they need to work with hardware vendors that can facilitate a smooth transition to next-generation technology when the OEM is ready.

The physical placement of embedded systems poses additional challenges for both OEMs and their customers. In many cases, these solutions are deployed in locations with limited access, making ongoing management and service difficult. OEMs need remote management capabilities to diagnose and resolve issues before they become problems.

OEMs also need hardware that is purpose-built for demanding physical conditions. For example, industrial automation solutions are often located in hot environments that are unprotected from dust or airborne particles. Systems used in kiosks or gaming systems can be squeezed into tight spaces where poor ventilation creates hot operating environments. To help ensure that the solutions function properly, OEMs need embedded systems that have a high heat threshold, can prevent dust accumulation, and can be configured to fit into small spaces.

DELIVERING PLATFORM STABILITY AND MANAGEABILITY

To address the challenges of producing embedded systems in demanding physical environments, Dell gathered suggestions and feedback directly from OEM organizations. Dell OEM Solutions experts then created a purpose-built platform to help meet these needs. The Dell OptiPlex XE is designed to provide a 3.5-year life cycle that includes a 6-month transition period for the long-term platform stability and streamlined manageability that OEMs and their customers require, while also offering a compact, robust design for the challenging physical environments of embedded systems. Leveraging the OptiPlex XE embedded system together with a comprehensive range of Dell OEM services enables enterprises to accelerate time to market, reduce costs, and increase operational efficiency—freeing them to create innovative industry solutions that meet business and organizational objectives and to grow at their own pace, regionally or globally.

"Leveraging the OptiPlex XE embedded system together with a comprehensive range of Dell OEM services enables enterprises to accelerate time to market, reduce costs, and increase operational efficiency."

Long-term platform stability

To help reduce the costs and burdens of constantly updating solutions to accommodate component changes, Dell designed the OptiPlex XE to offer a 3.5-year life cycle—substantially longer than many off-the-shelf PCs. By locking down key components, Dell helps reduce the changes that might be made to the processors, power supply units (PSUs), motherboards, and BIOS. As a result, OEMs do not have to drain precious resources to constantly recertify hardware, modify images, or support a dizzying array of product configurations.

The Dell OEM Solutions team regularly shares the technology road map with OEMs, allowing those organizations to decide which new technologies to integrate into their solutions and plan for changes well ahead of time. When an OEM is ready to upgrade its platform, the Dell OEM Solutions team then provides life cycle management support to help ensure a smooth transition to the latest technologies. In the case of the OptiPlex XE, the 3.5-year life cycle includes a 6-month overlap in availability for new and existing products, providing a window to test and validate the new hardware in preparation for a gradual transition according to the OEM's timeline.

Dell also helps ensure that the OptiPlex XE receives full warranty support, offering a standard 3-year warranty and an optional extended 5-year warranty starting from the date of purchase. Whether OEM customers select a 3- or 5-year warranty, Dell continues to provide technical support and replacement of legacy components for the full warranty period. The combination of tier 1 manufacturing processes, the 3.5-year period when the system is available for purchase, and the optional 5-year warranty from the date of purchase mean that the OptiPlex XE can potentially provide a total platform life cycle for OEMs of up to 8.5 years.

Streamlined manageability

Because embedded industry solutions are often beyond the easy physical reach of support personnel, Dell integrated robust remote management capabilities into the OptiPlex XE platform. The OptiPlex XE is equipped with Broadcom® TruManage™ systems management technology, which can provide remote asset management, power control, user account management, and text console redirection capabilities. TruManage also generates alerts when the fan operations or temperature reach abnormal levels for the overall system, a processor, or a PSU. TruManage technology supports the Desktop and Mobile Architecture for System Hardware (DASH) and Platform Management Component Intercommunication (PMCI) protocols to provide OEMs with the ability to manage systems across multiple locations using a common framework and tools. Many software vendors provide support for TruManage technologies—for example,

The Dell OptiPlex XE platform, available in two form factors, is purpose-built for the challenging environments of embedded systems

> **"Because embedded industry solutions are often beyond the easy physical reach of support personnel, Dell integrated robust remote management capabilities into the OptiPlex XE platform."**

administrators can access TruManage capabilities through the Dell Management Console for Clients (formerly Dell Client Manager).

Dell has also integrated additional design elements and capabilities into the OptiPlex XE to further streamline ongoing management. For example, an optional integrated watchdog timer provides self-monitoring capabilities that can restore a hung system to a working state, helping reduce the number of in-person visits required by support personnel. When hands-on repair is required, the tool-less chassis facilitates easy access to components, including the PSU. The OptiPlex XE can also be configured to use a routing pin to provide external power access so that administrators or users can power the system up or down without having to open the enclosure to access the system directly.

If hardware problems arise, OEMs and their customers can enlist Dell ProSupport services. Whether OEMs are using the OptiPlex XE or another Dell product, they can integrate Dell ProSupport into their global support infrastructure, offering customers an array of options for resolving issues, delivering spare parts, and providing on-site assistance around the world.

Compact, robust design

The OptiPlex XE was designed to withstand high-heat environments throughout an extended life cycle within locked cabinets, outdoor kiosks, and tight enclosures with minimal venting. The system design helps keep the OptiPlex XE cool by pulling air from the front and using internal baffles to direct airflow inside the system away from critical components. But even in hot environments, the OptiPlex XE can continue to operate as it should. When equipped with integrated graphics, the system is rated for 45°C (113°F) ambient environments and can be configured to tolerate temperatures up to 55°C (131°F) with the ducting kit. These thresholds are higher than many off-the-shelf systems and commercially available systems, such as the HP rp5700 desktop PC. Using the optional ducting kit, the OptiPlex XE has a 57 percent higher operating temperature threshold than any other OptiPlex system. To help protect internal components from dust or other airborne particles, Dell also offers an optional dust filter that can be inserted and removed without having to remove the bezel.

Dell also designed the OptiPlex XE to fit into very small enclosures, with versatile "go-anywhere" mounting that allows the system to fit in virtually any direction. With small-form-factor or desktop models available, OEMs can select the design that accommodates the enclosure space for their solution. Mounting holes on the side of the chassis allow for flexible positioning. Even in a small space, the system can support a variety of legacy peripherals, providing native support for dual network interface cards (NICs) as well as serial, USB, PS/2, VGA, and DisplayPort interfaces. OEMs can optionally equip the OptiPlex XE with powered USB and serial ports, helping save space in small physical environments by avoiding the need for separate power units.

CUSTOMIZING AND SERVICING PURPOSE-BUILT DESIGNS

In addition to supplying purpose-built hardware, Dell offers a comprehensive range of services to help customize embedded system platforms. For example, the Dell OEM Solutions team can procure and integrate components; produce Dell, OEM, or customer co-branding; install OEM images or software; and ship solutions directly to OEM customers through a worldwide distribution network, including providing regulatory support around the globe—enabling the OEMs to reduce their own costs and stay focused on core competencies. Dell OEM Solutions experts also help organizations accelerate the development of new products by offering life cycle management, including access to technology road maps to facilitate planning.

With global support and options for regional hardware production, the Dell OEM Solutions team helps organizations reach customers around the world. Whether embedded systems are based on the OptiPlex XE or another Dell platform, Dell hardware is designed with the flexibility to meet rigorous industry requirements while providing platform stability and streamlined management. This approach enables OEMs to continue creating innovative product solutions to help customers achieve business and organizational goals.

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[TOUGH QUESTION #21]

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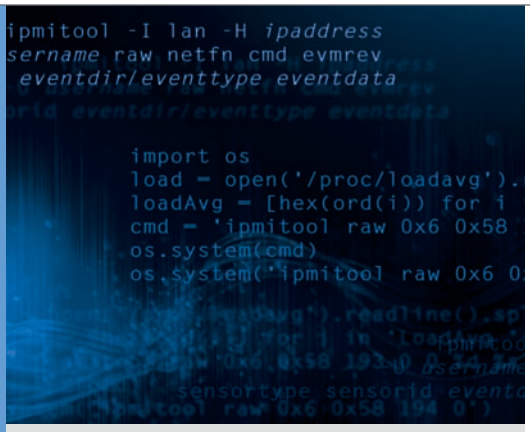

REMOTE MANAGEMENT USING MICROSOFT WINDOWS POWERSHELL AND THE DELL LIFECYCLE CONTROLLER

By Steven Grigsby
Jon Hass
Gong Wang
Weijia (John) Zhang, Ph.D.

The Microsoft® Windows Server® 2008 R2 OS and version 1.2 of the Dell™ Lifecycle Controller provide a rich set of remote deployment and management capabilities for Dell PowerEdge™ servers. By taking advantage of the Windows PowerShell™ command-line interface in conjunction with the Lifecycle Controller, administrators can simplify and streamline systems management throughout the enterprise.

Server provisioning and management can be time-consuming and complex processes—especially when dealing with highly customized configurations, deploying multiple servers simultaneously, or managing thousands of servers scattered around the world. Combining the Windows PowerShell command-line interface (CLI) in the Microsoft Windows Server 2008 R2 OS with version 1.2 of the Dell Lifecycle Controller offers administrators a rich set of features to help simplify and streamline remote deployment and management of 11th-generation Dell PowerEdge servers throughout the enterprise.

REMOTE MANAGEMENT IN WINDOWS SERVER 2008 R2

Windows PowerShell, originally included as an optional feature in Windows Server 2008, provides a command-line shell designed specifically to help simplify systems management, accelerate automation, and increase productivity. It integrates with the Microsoft .NET Framework and provides an environment to perform a variety of administrative tasks by executing cmdlets (specialized .NET classes implementing a particular operation), executing scripts (compositions of cmdlets along with imperative logic), running stand-alone executable applications, or instantiating regular .NET classes.

In the Windows Server 2008 R2 and Windows® 7 operating systems, Windows PowerShell 2.0 is now installed by default, and incorporates enhanced remote management capabilities using both the command-line shell and script automation. The remote management features are based on Windows Remote Management (WinRM), the Microsoft implementation of the Web Services for Management (WS-Management) protocol, which is designed to provide secure encrypted communication between the management console applications and the managed system. This Web services basis for the WS-Management protocol enables remote sessions to work through firewalls that pass standard HTTP over Secure Sockets Layer (HTTPS) protocols, allowing administrators to manage systems across the Internet.

Fan-out and fan-in management

Remote management typically uses either a *fan-out* (one to many) or *fan-in* (many to one) configuration. In the fan-out configuration—the more common of the two—administrators on a single local management console can run Windows PowerShell commands to simultaneously manage many remote systems. To support this configuration, Windows PowerShell requires the WS-Management protocol and the WinRM service. When connecting to a remote system, WS-Management establishes a connection and uses a plug-in for Windows PowerShell to start the Windows PowerShell host process (wsmprovhost.exe) on the remote system. Administrators can specify an alternate port, an alternate session configuration, and other features to customize the remote connection.

In the fan-in configuration, managed systems connect to a single management system running Windows PowerShell. To support this configuration, Windows PowerShell uses Internet Information Services (IIS) to host WS-Management, load the Windows PowerShell plug-in, and start Windows PowerShell. Rather than starting each Windows PowerShell session in a separate process, all sessions run in the same host process. IIS hosting and fan-in remote management are not supported in the Windows Server 2003 or Windows XP operating systems.

System configuration

Remote management in Windows Server 2008 R2 between two Windows environments requires that the local and remote systems have Windows PowerShell 2.0 or later, Microsoft .NET Framework 2.0 or later, and WinRM 2.0 or later. Administrators must change the default WS-Management configuration on each managed system to enable remote management, which they can do by launching Windows PowerShell (using the "Run as administrator" option in the Microsoft Windows Vista® OS and later versions of Windows) and then entering the command `enable-psremoting`. This command enables users on other systems to establish remote connections and run remote commands on the local system, and to create loopback connections on the local system. To help verify that the system is configured correctly, administrators can run a test command such as `new-pssession`, which creates a remote session on the local system.

Interactive Windows PowerShell sessions

Generally, the easiest way to run remote commands is to start an interactive session with a single remote system using the Enter-PSSession cmdlet. When an interactive session starts, commands entered on the local console run on the remote system just as if they had been entered directly on that system. Administrators can connect to only one remote system in each interactive session.

For example, administrators could start an interactive session with a server designated as "PE-R710-01" using the command `enter-pssession PE-R710-01`. The command prompt then changes to indicate the server connection:

```
PE-R710-01\PS>
```

Administrators can now enter commands to run on this server, and then end the interactive session when they are done using the command `exit pssession`.

Temporary Windows PowerShell connections

Administrators can run commands on one or more remote systems by using the Invoke-Command cmdlet to create a temporary connection with those systems. They can do so using the following command syntax:

```
PS C:\Users\administrator.OSELABNET> hostname
PE-R410-01
PS C:\Users\administrator.OSELABNET> invoke-command -computername PE-R710-01 -scriptblock {

Handles  NPM(K)    PM(K)      WS(K) VM(M)   CPU(s)     Id ProcessName          PSComputerName
-------  ------    -----      ----- -----   ------     -- -----------          --------------
     35       5     3260       5260    43     0.09   2532 conhost             pe-r710-01
    308       9     3180       3980    44     0.22    448 csrss               pe-r710-01
    129       8     3132       5272    41     1.22    488 csrss               pe-r710-01
    170      11     3196       6000    42     1.08   2444 csrss               pe-r710-01
     81       7     2004       5444    50     0.02    812 dwm                 pe-r710-01
     81       7     2012       5524    50     0.02   2368 dwm                 pe-r710-01
    516      33    16044      28028   165     0.70   1132 explorer            pe-r710-01
    512      33    16440      29172   153     1.03   2272 explorer            pe-r710-01
      0       0        0         24     0              0 Idle                pe-r710-01
    740      20    21956      29196    69     1.26    592 lsass               pe-r710-01
    180       7     3796       5408    19     0.02    600 lsm                 pe-r710-01
    162      17     4692       8496    61     0.09   2020 msdtc               pe-r710-01
    849      29    62472      71380   591     1.86   1936 powershell          pe-r710-01
    258      15     9308      12876    46     1.01    584 services            pe-r710-01
     47       2     1100       1344     5     0.06    344 smss                pe-r710-01
    347      20     8332      12372    82     0.02   1068 spoolsv             pe-r710-01
    509      42    19272      23096   154     1.84    192 svchost             pe-r710-01
    329      33    11852      14016    51     0.23    488 svchost             pe-r710-01
    395      17     7264      11728    46     0.31    712 svchost             pe-r710-01
    277      16     4984       8328    34     0.42    788 svchost             pe-r710-01
    336      16    13084      15976    47     0.41    872 svchost             pe-r710-01
    921      39    25816      37892   126     1.70    916 svchost             pe-r710-01
    343      22     8404      13304    44     0.17    964 svchost             pe-r710-01
    267      17     9176      14536    66     0.14   1004 svchost             pe-r710-01
     63       4     2296       3916    13     0.00   1152 svchost             pe-r710-01
    502       0      100         60     3              4 System              pe-r710-01
    157      11     4008       6820    52     0.02   1660 taskhost            pe-r710-01
    158      11     4060       6836    52     0.02   2360 taskhost            pe-r710-01
    138      10     4464       9356    60     1.09   1752 TrustedInstaller    pe-r710-01
     96      10     2844       4812    45     0.14    496 wininit             pe-r710-01
    115       7     4524       7600    30     0.09    536 winlogon            pe-r710-01
    114       7     3676       6744    29     0.16   3004 winlogon            pe-r710-01
    233      34    49168      52996   536     0.97    640 wsmprovhost         pe-r710-01
    204      33    40828      52280   536     0.47   2364 wsmprovhost         pe-r710-01

PS C:\Users\administrator.OSELABNET>
```

Figure 1. *Example results of the Microsoft Windows PowerShell Get-Process cmdlet*

```
invoke-command -computername computername
   -scriptblock {commands}
```

The `-computername` parameter specifies which remote systems to run the commands on, with multiple names delimited with commas; the `-scriptblock` parameter specifies which commands to run. For example, administrators could run the Get-Process cmdlet on the PE-R710-01 server as follows:

```
invoke-command -computername PE-R710-01
   -scriptblock {get-process}
```

This command would then return the running processes on the system (see Figure 1).

Persistent Windows PowerShell connections

A persistent connection with one or more remote systems can be useful when administrators want to run multiple commands without needing to reestablish a temporary session before each command. For example, the following command creates Windows PowerShell sessions on servers designated as "PE-R710-01" and "PE-R710-02" and saves those sessions in the `$s1` and `$s2` variables:

```
$s1, $s2 = new-pssession -computername
   PE-R710-01, PE-R710-02
```

Administrators can then reference the sessions by using the `$s1` or `$s2` variables with the Enter-PSSession or Invoke-Command cmdlets, using commands such as the following:

```
enter-pssession -session $s1
invoke-command -session $s2 -scriptblock
   {get-process}
```

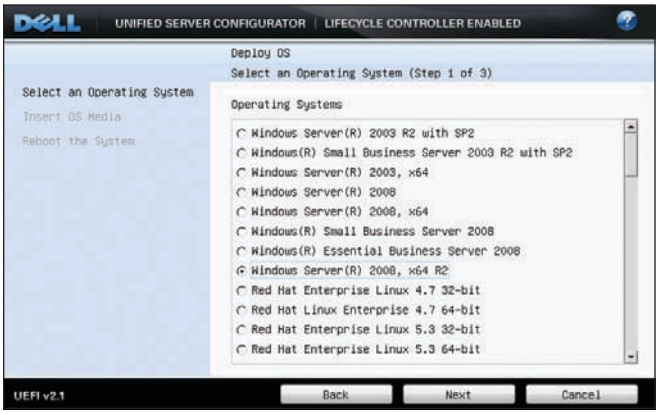

Figure 2. *Microsoft Windows Server 2008 R2 deployment in version 1.2 of the Dell Lifecycle Controller*

WINDOWS POWERSHELL AND THE DELL LIFECYCLE CONTROLLER

The Dell Lifecycle Controller is an engine for advanced embedded management, delivered as part of the Integrated Dell Remote Access Controller (iDRAC) Express server platform service processor in 11th-generation Dell PowerEdge servers. Administrators can use Windows PowerShell and WinRM to directly manage the Dell Lifecycle Controller using the WS-Management protocol. Lifecycle Controller version 1.2 incorporates OS deployment support for Windows Server 2008 R2 and other operating systems. For systems with an earlier Lifecycle Controller version, administrators can upgrade the Dell Unified Server Configurator from ftp.dell.com or support.dell.com, and then deploy Windows Server 2008 R2 (see Figure 2).

WS-Management interface

The Lifecycle Controller remote management interface is a Web service based on the WS-Management protocol and Distributed Management Task Force (DMTF) Common Information Model (CIM) payloads. The Dell embedded server platform management interfaces are organized into profiles that define interfaces for dealing with particular management domains or areas of functionality. The Lifecycle Controller provides implementations of multiple platform management profiles defined by the DMTF Systems Management Architecture for Server Hardware (SMASH) 2.0 specification. Dell has also defined profile extensions that provide interfaces for capabilities specific to the Lifecycle Controller.

The Lifecycle Controller WS-Management implementation uses Secure Sockets Layer (SSL) for transport security and supports basic and digest authentication. In addition, the iDRAC supports validating credentials against cached credentials and third-party authentication services such as the Microsoft Active Directory® directory service. The credentials must be for an administrator or have server command execution privileges. iDRAC administrators can use the Web services interfaces directly by taking advantage of the Windows PowerShell client infrastructures and WinRM CLIs as well as application programming environments such as Microsoft .NET.[1]

Previous versions of the Lifecycle Controller enabled administrators to carry out monitoring, updating, OS deployment, and diagnostic functions in a one-to-one local fashion. Lifecycle Controller version 1.2 incorporates the WS-Management network protocol to provide enhanced out-of band remote management capabilities based on industry standards. Combining Windows PowerShell with the WS-Management interfaces in the Lifecycle Controller enables administrators to perform remote systems management directly over the network, independent of the OS and regardless of whether the server is powered up or down. This combination helps simplify systems management for administrators who prefer creating their own management solutions rather than relying on proprietary third-party solutions.

Remote management using the WinRM cmdlet

The Windows PowerShell WinRM cmdlet provides remote access to the Lifecycle Controller from the Windows PowerShell environment. The administrator remotely managing the systems provides the host name or IP address of the Lifecycle Controller as well as the appropriate login credentials. Figure 3 shows sample syntax for the WinRM cmdlet as displayed in the Windows PowerShell interface; administrators can use the `i` operation to directly invoke methods exposed by the Lifecycle Controller, including retrieving driver pack information, expanding a driver pack, and booting from an ISO image located on a network share (see Figure 4).

The first example command shown in Figure 4 retrieves information on the Lifecycle Controller driver pack, which contains non-native OS drivers for devices supported on that system that are stored in the Lifecycle Controller. This command invokes the GetDriverPackInfo method supported by the OSDDeploymentService provider: `-u:`*`username`* `-p:`*`password`* provides the username and password credentials, `-encoding:utf-8` specifies UTF-8 encoding, and `-a:basic` specifies basic authentication. The resource Uniform Resource Identifier (URI) in the command identifies the WS-Management provider for remotely enabling OS deployment, while `-r:https://`*`ipaddress`*`:443/wsman` specifies the URL and port for the WS-Management connection.

```
winrm OPERATION RESOURCE_URI [-SWITCH:VALUE [-SWITCH:VALUE] ...]
      [@<KEY=VALUE[;KEY=VALUE]...>]

For help on a specific operation:
  winrm g[et] -?          Retrieving management information.
  winrm s[et] -?          Modifying management information.
  winrm c[reate] -?       Creating new instances of management resources.
  winrm d[elete] -?       Remove an instance of a management resource.
  winrm e[numerate] -?    List all instances of a management resource.
  winrm i[nvoke] -?       Executes a method on a management resource.
  winrm id[entify] -?     Determines if a WS-Management implementation is
                          running on the remote machine.
  winrm quickconfig -?    Configures this machine to accept WS-Management
                          requests from other machines.
  winrm configSDDL -?     Modify an existing security descriptor for a URI.
  winrm helpmsg -?        Displays error message for the error code.
```

Figure 3. *Sample syntax for the Microsoft Windows PowerShell WinRM cmdlet*

[1] For more information on using Web services in CLI and scripting environments, visit www.delltechcenter.com/page/Lifecycle+Controller.

Retrieving driver pack information:

```
winrm i GetDriverPackInfo cimv2/root/dcim/DCIM_OSDeploymentService?CreationClassName=DCIM_OSDeploymentService
  +Name=DCIM:OSDeploymentService+SystemCreationClassName=DCIM_ComputerSystem+SystemName=DCIM:ComputerSystem
  -u:username -p:password -r:https://ipaddress:443/wsman -SkipCNCheck -SkipCACheck -encoding:utf-8 -a:basic
```

Expanding driver pack in the embedded storage for external use:

```
winrm i UnpackAndAttach cimv2/root/dcim/DCIM_OSDeploymentService?CreationClassName=DCIM_OSDeploymentService
  +Name=DCIM:OSDeploymentService+SystemCreationClassName=DCIM_ComputerSystem+SystemName=DCIM:Computer
  System -u:username -p:password -r:https://ipaddress/wsman:443 -SkipCACheck -SkipCNCheck -encoding:utf-8
  -a:basic @{OSName="osname";ExposeDuration="00000000003500.000000:000"}
```

Booting from an ISO image:

```
winrm i BootToNetworkISO cimv2/root/dcim/DCIM_OSDeploymentService?CreationClassName=DCIM_OSDeploymentService
  +Name=DCIM:OSDeploymentService+SystemCreationClassName=DCIM_ComputerSystem+SystemName=DCIM:Computer
  System -u:username -p:password -r:https://ipaddress/wsman:443 -SkipCNCheck -SkipCACheck -encoding:utf-8
  -a:basic @{IPAddress="ipaddress2";ShareName="/nfs";ShareType="0"; Username="shareuser"; Password=
  "sharepassword";Workgroup="workgroup";ImageName="imagename"}
```

Figure 4. *Example commands using the Microsoft Windows PowerShell WinRM cmdlet*

Administrators would use the second example command to expose the drivers in the OS using the Lifecycle Controller driver pack. This command uses the `UnpackAndAttach` method to request that the target system's Lifecycle Controller expand the out-of-box drivers in the driver pack stored in the Lifecycle Controller to a virtual USB drive. In this method, the OS is specified by passing the OS name (such as `"Windows Server(R) 2008"`) to the method; the list of supported operating systems can be retrieved by calling the method in the first example.

The third example command remotely boots a server from an ISO image located on a network share and mounted by the Lifecycle Controller as a virtual USB device. This command invokes the OSDDeploymentService `BootToIso` method and passes the location of the ISO image on the command line. Administrators can customize the ISO image to a specific pre-OS environment to initiate the installation and use the previously unpacked drivers from the Lifecycle Controller driver pack.

Other commands can also be useful for OS deployment tasks such as downloading the driver pack, booting to the Preboot Execution Environment (PXE), and checking job status. Administrators may need to detach the storage or image after the OS deployment operation is complete.

SIMPLIFIED, STREAMLINED SYSTEMS MANAGEMENT

The Microsoft Windows PowerShell features in Windows Server 2008 R2 provide a flexible way to access the rich management features exposed by the Dell Lifecycle Controller. Combining Windows PowerShell with the Lifecycle Controller can enable administrators to simplify and streamline remote systems management of 11th-generation Dell PowerEdge servers.

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POWER MANAGEMENT IN MICROSOFT WINDOWS SERVER 2008 R2 AND 11TH-GENERATION DELL POWEREDGE SERVERS

By Thomas Cantwell
Greg Darnell
Peter Tsai

The Microsoft® Windows Server® 2008 R2 OS incorporates enhanced power management tools that can complement 11th-generation Dell™ PowerEdge™ server capabilities such as the Dell Active Power Controller feature to help control power consumption and increase energy efficiency in enterprise data centers.

The Microsoft Windows Server 2008 R2 OS includes incremental and evolutionary enhancements for server power management that take advantage of key hardware technologies and capabilities incorporated into 11th-generation Dell PowerEdge servers with the Intel® Xeon® processor 5500 series. Together, Windows Server 2008 R2 and the Dell Energy Smart architecture in these servers can complement each other, offering hardware- and software-based reporting and control mechanisms to help IT administrators accurately size infrastructures, monitor power consumption, and manage their environments. Understanding the key characteristics of OS power management as well as 11th-generation PowerEdge capabilities such as the Dell Active Power Controller (DAPC) feature—including their relative efficiencies under different operating conditions—can help administrators use each approach to best advantage in their own environments.

KEY POWER MANAGEMENT ENHANCEMENTS

Although processors generally consume a smaller proportion of overall server power than they did a few years ago, they still require a significant amount of energy. Administrators can control the power consumption of Intel Xeon processors through two primary mechanisms:

- **P-states:** P-states manage processor power consumption by modulating processor power and frequency.
- **C-states:** C-states are processor sleep states, which for Intel Xeon processors run from C0 (a fully operational state) to C6 (currently the lowest possible state for these processors).

The Intel Xeon processor 5500 series and DAPC in 11th-generation Dell PowerEdge servers offer increased control over processor power consumption. The Intel Xeon processor 5500 series and supported chipsets are designed to provide enhanced C-state capabilities compared with previous-generation processors. DAPC provides a firmware-based mechanism for controlling P-states that can complement Windows Server 2008 R2 OS power management capabilities.[1]

The core parking feature in Windows Server 2008 R2 provides a processor scheduling policy designed to minimize the number of cores in use, enabling unused cores to enter a lower C-state when they are not needed. Because of the increasing prevalence

[1] For more information on power management capabilities in 11th-generation Dell PowerEdge servers, see "Optimizing the Data Center: New Dell Servers and the Dell Energy Smart Architecture," by Daniel Bounds, John Jenne, and Robert Hormuth, in *Dell Power Solutions*, June 2009, DELL.COM/Downloads/Global/Power/ps2q09-20090247-Bounds.pdf; and "Dell Energy Smart Architecture (DESA) for 11G Rack and Tower Servers," by John Jenne, Vijay Nijhawan, and Robert Hormuth, Dell Inc., 2009, DELL.COM/Downloads/Global/Products/PEdge/DESA_Whitepape_Rack_TowerServers_en.pdf.

of multi-core processors, effective management of core usage can potentially reduce power consumption on a wide variety of systems. Figure 1 shows the Windows Server 2008 R2 Resource Monitor for a PowerEdge R610 server with two quad-core Intel Xeon processors, clearly displaying which cores have been parked.

Windows Server 2008 R2 also includes enhanced control over P-states, which helps control server power consumption—although this is one area where DAPC can provide advantages over OS power management under certain circumstances. Administrators can monitor and manage both P-states and C-states using Windows Management Instrumentation (WMI) and Group Policy when OS power management is enabled. Because DAPC manages P-states at the firmware level, P-state control and monitoring are not available to the OS when DAPC is enabled. However, organizations can still benefit from other Windows Server 2008 R2 power management features such as core parking even when DAPC is on.

Other power management enhancements in Windows Server 2008 R2 include the following:

- **Intelligent Timer Tick Distribution (ITTD):** ITTD extends processor sleep states by not waking the processor unnecessarily.
- **One-to-many power management:** This feature is primarily a management tool, but can be useful if IT staff routinely push out power management changes. As part of this overall infrastructure, Windows Server 2008 R2 also introduces an enhanced Power Metering and Budgeting interface to instrument and manage servers.[2]
- **Individual setting control:** Administrators can now individually control and manage each power management setting, providing a much finer level of control compared with managing settings as a group.[3]

DAPC AND OS POWER MANAGEMENT EFFICIENCY

Both Dell and Microsoft have focused significant engineering efforts on enhancing server energy efficiency. But for IT administrators, where are the inflection points? When does it make sense to choose DAPC over OS power management and vice versa?

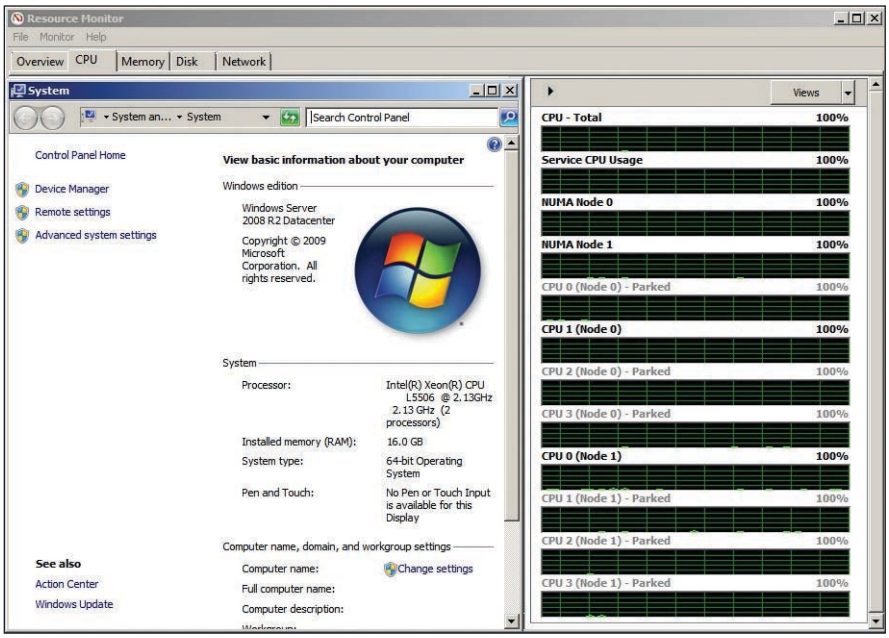

Figure 1. *Core parking shown in the Microsoft Windows Server 2008 R2 Resource Monitor*

First of all, DAPC and Windows Server 2008 R2 OS power management approaches can complement each other in several ways. Because DAPC affects only P-states, not C-states, many environments can benefit from using DAPC along with the additional C-state control offered by the OS. In addition, the 11th-generation Dell PowerEdge server BIOS implements Advanced Configuration and Power Interface (ACPI) 4.0 Power Metering objects that allow monitoring through the Windows Server 2008 R2 Power Meter Interface (PMI), enabling OS events to be triggered when administrator-defined thresholds are reached. This integration provides an additional standardized mechanism for monitoring power consumption in the data center.

However, DAPC and OS power management can also offer specific advantages under different circumstances. DAPC is designed to provide power savings over OS power management at utilization levels of roughly 40–90 percent; at low and very high utilizations, DAPC and OS power management tend to converge. The WMI capabilities introduced in Windows Server 2008 R2 can offer different ways to control power management settings, but if administrators want to take a "set it and forget it" approach, and if testing in the specific environment demonstrates that DAPC can provide higher efficiency than OS power management, then DAPC would generally be recommended.

To demonstrate the relative efficiency of DAPC and OS power management under different conditions, in June 2009 Dell engineers used industry-standard benchmarks to evaluate power consumption in two PowerEdge server models across a range of utilization levels from idle to the maximum throughput achievable on each model. The first was an 11th-generation PowerEdge R710 configured with two quad-core Intel Xeon X5570 processors at 2.93 GHz; 8 GB of RAM; a

[2] For more information on this interface, visit msdn.microsoft.com/en-us/library/dd573949.aspx.

[3] For more information on Microsoft Windows® OS power management features, visit www.microsoft.com/whdc/system/pnppwr.

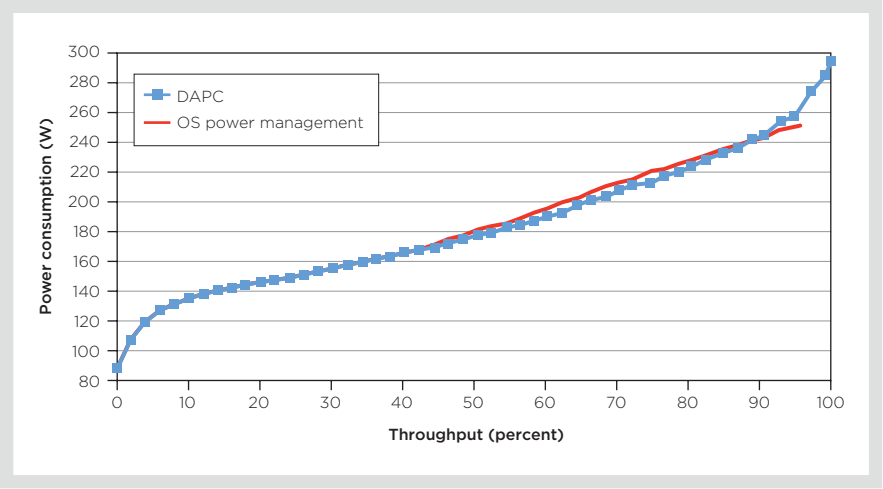

Figure 2. *Power consumption for DAPC and Windows Server 2008 R2 OS power management (0–100 percent throughput)*

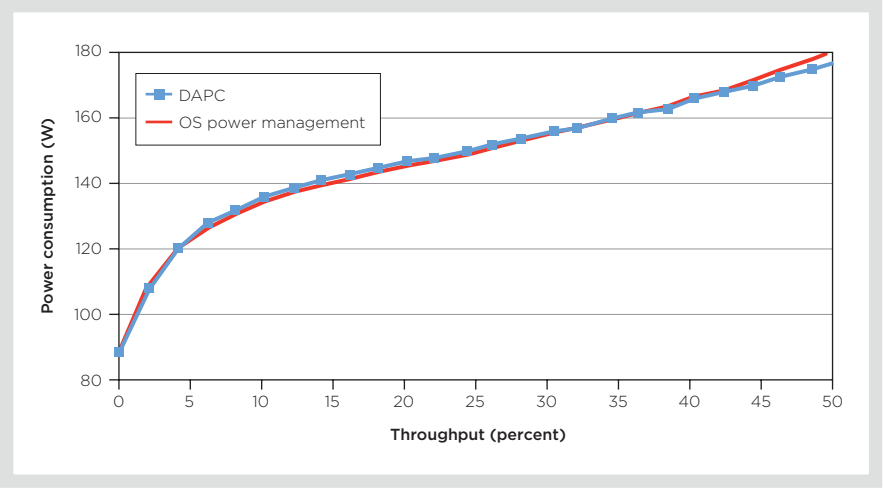

Figure 3. *Power consumption for DAPC and Windows Server 2008 R2 OS power management (0–50 percent throughput)*

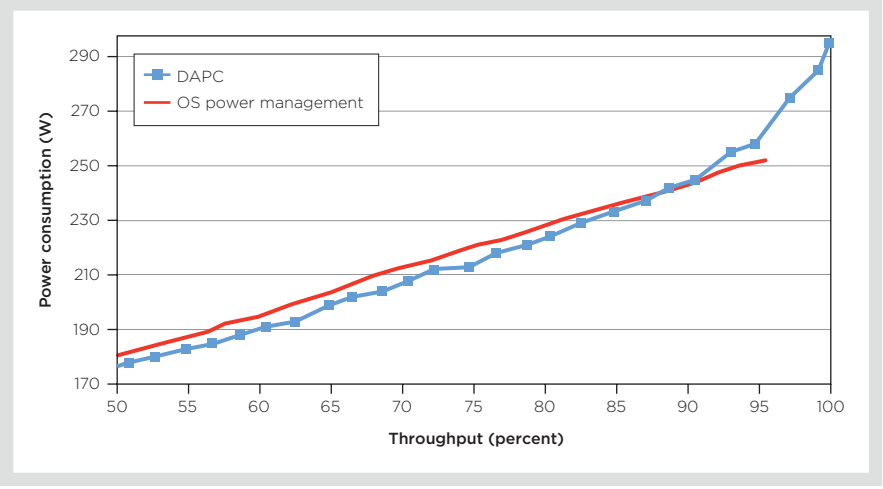

Figure 4. *Power consumption for DAPC and Windows Server 2008 R2 OS power management (50–100 percent throughput)*

250 GB, 7,200 rpm Serial ATA (SATA) hard drive; a Dell Serial Attached SCSI (SAS) 6/iR storage controller; one 570 W power supply unit (PSU); and a default installation of Windows Server 2008 R2. The second server was a 10th-generation PowerEdge 2950 configured with two quad-core Intel Xeon E5345 processors at 2.33 GHz; 8 GB of RAM; a 250 GB, 7,200 rpm SATA hard drive; a Dell SAS 6/iR storage controller; one 750 W PSU; and a default installation of Windows Server 2003 R2 with Service Pack 2 (SP2).

In the first set of tests, the Dell team compared DAPC against Windows Server 2008 R2 OS power management in the 11th-generation PowerEdge R710 server. Figure 2 shows the resulting data set across the full tested throughput range, while Figures 3 and 4 show the same data specifically for the 0–50 percent and 50–100 percent throughput ranges, respectively. As these results show, OS power management has a slight edge when throughput is below 40 percent of a system's peak capabilities, while DAPC has a significant advantage when throughput is above 40 percent.

In the second set of tests, the Dell team compared the 11th-generation PowerEdge R710 running Windows Server 2008 R2 against the 10th-generation PowerEdge 2950 running Windows Server 2003 R2 with SP2. Figure 5 shows the results. In these tests, the PowerEdge 2950 drew 251 W at its peak throughput. The PowerEdge R710, in contrast, drew 218 W at its peak—consuming 13 percent less power than the PowerEdge 2950 while providing 66 percent higher maximum throughput.

These tests illustrate the dramatic difference that latest-generation hardware and software can have on overall system power consumption and throughput. For organizations that are considering an upgrade but are concerned about the initial capital outlay, the results may provide some idea of the long-term possibilities and efficiencies that latest-generation systems can offer.

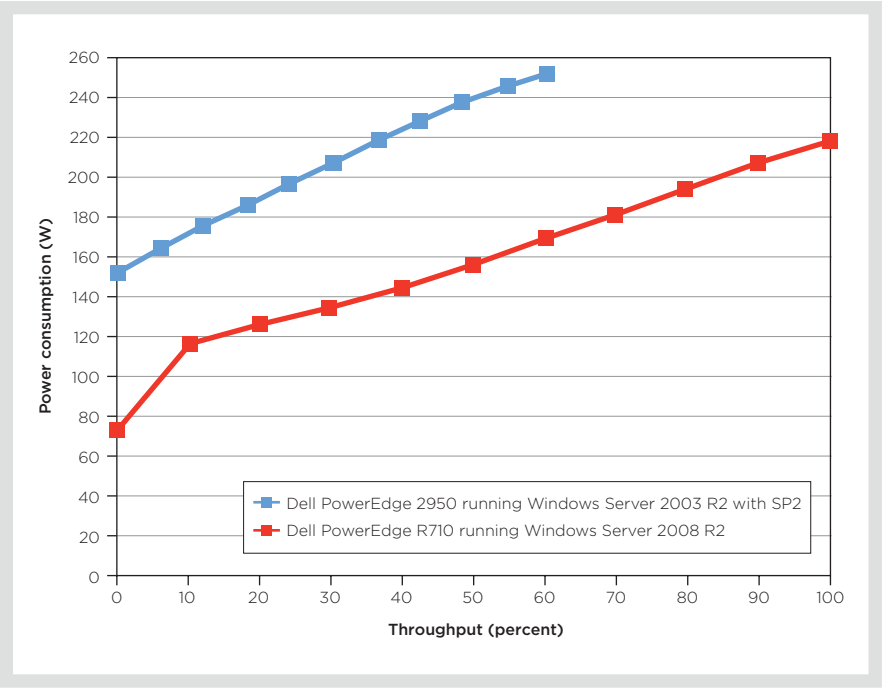

Figure 5. *Performance and power consumption for 10th- and 11th-generation Dell PowerEdge servers*

Administrators should keep in mind that results may vary depending on configuration and workload; to identify the appropriate power management approach in their own environments, they should test their specific systems and workloads.

BEST PRACTICES FOR DATA CENTER ENERGY EFFICIENCY

How efficiently a data center runs depends primarily on three factors: hardware capability, firmware capability, and software capability. To achieve maximum efficiency, these three elements must work together. By running Microsoft Windows Server 2008 R2 on 11th-generation Dell PowerEdge servers, organizations can help ensure effective power management at all three levels, with latest-generation Dell hardware and firmware capabilities such as DAPC providing a complement to the enhanced OS power monitoring and management features in Windows Server 2008 R2.

As always, testing with actual workloads in an organization's specific IT environment is crucial to determining the appropriate power management approach for that environment. Upgrading to latest-generation servers and software and investing in the up-front effort to evaluate the systems in the context of production workloads can help administrators significantly reduce costs for systems, power, cooling, and space.

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OPTIMIZING MICROSOFT EXCHANGE SERVER 2010 DEPLOYMENTS ON DELL SERVERS AND STORAGE

By Casey Birch
Stanley L. Stevens

Dell has created three architecture models for configuring Microsoft® Exchange Server 2010 messaging environments. These best-practice models combine the performance and efficiency enhancements of 11th-generation Dell™ PowerEdge™ servers and leading-edge Dell storage platforms with the productivity and manageability gains enabled by Exchange Server 2010—allowing enterprises to design cost-effective messaging platforms to meet their specific needs.

Microsoft Exchange Server 2010 offers a range of enhancements designed to dramatically advance user productivity and simplify manageability—including exceptional performance, large mailbox sizes, and built-in high-availability features. These enhancements also enable organizations to take advantage of recent technology advances that help increase the efficiency of Exchange messaging platforms and reduce the cost of deploying and supporting Exchange Server 2010.

As a starting point, Dell has created three architecture models to help enterprises optimize the productivity and manageability benefits of Exchange Server 2010 messaging environments. These models offer administrators the flexibility to design their own Exchange Server 2010 platform deployments to meet specific organizational requirements. The configurations explored in this article are designed to leverage technology advances that enhance performance, power efficiency, memory capacity, availability, management, and data protection capabilities across a broad range of server and storage platforms, including 11th-generation Dell PowerEdge servers, Dell EqualLogic™ PS Series Internet SCSI (iSCSI) storage area network (SAN) arrays, Dell/EMC CX4 Series SAN arrays, and Dell PowerVault™ direct attach storage (DAS). By deploying Exchange Server 2010 on 11th-generation PowerEdge servers and Dell storage systems, IT organizations can cost-effectively address a comprehensive range of messaging requirements while dramatically increasing user productivity and management efficiency.

BOOSTING PRODUCTIVITY AND MANAGEABILITY

Key features in Microsoft Exchange Server 2010 designed to enhance user productivity and manageability include the following:

- **Massive reduction in disk I/O:** Previous releases of Exchange often generated large amounts of disk I/O, which could limit storage options and hamper user productivity. Exchange Server 2010 enables dramatic reductions in disk I/O compared with previous versions, providing enhanced user productivity, flexibility, and cost-efficiency in storage options. For example, organizations now may elect to use Serial ATA (SATA) drives and nearline Serial Attached SCSI (SAS) drives instead of having to rely on more expensive SAS or Fibre Channel drives.
- **Increased mailbox sizes:** Traditionally, end users have had to spend significant amounts of time managing e-mail because of mailbox size limits. Exchange Server 2010 supports expanded 10 GB mailboxes, which can enhance user productivity by

reducing the time spent managing and searching e-mail. Also, increased mailbox sizes combined with performance enhancements such as reduced disk I/O enable mailboxes to be stored on large, cost-effective storage arrays.

- **Built-in high-availability and disaster recovery features:** Exchange Server 2010 offers several high-availability and disaster recovery features. Built-in storage replication, for example, allows up to 16 copies of the Exchange database to be automatically distributed, kept up-to-date, and recovered in the event of a disaster. These built-in features offer organizations a simple option for helping ensure application uptime.
- **Native archiving:** The proliferation of .pst files has emerged as a huge challenge to meeting data protection and compliance demands. Exchange Server 2010 offers advanced archiving and compliance capabilities that, when combined with large mailbox sizes, help organizations to ensure data protection and compliance without the use of these files.

Additionally, 11th-generation Dell PowerEdge servers and Dell storage—including Dell EqualLogic PS Series iSCSI SAN arrays, Dell/EMC CX4 Series SAN arrays, and Dell PowerVault DAS systems—provide significant performance and efficiency enhancements that help organizations take advantage of Exchange capabilities while optimizing the efficiency and cost-effectiveness of their messaging database infrastructures. U.S. ENERGY STAR–certified 11th-generation PowerEdge servers are designed to offer significantly greater power efficiency than 10th-generation PowerEdge servers; 11th-generation PowerEdge servers can also provide up to triple the processing power of 9th-generation PowerEdge servers.[1] Enhancements in EqualLogic arrays include advanced management and protection software incorporated into the arrays at no additional cost, as well as native Microsoft Exchange Volume Shadow Copy Service (VSS) integration for advanced data protection.

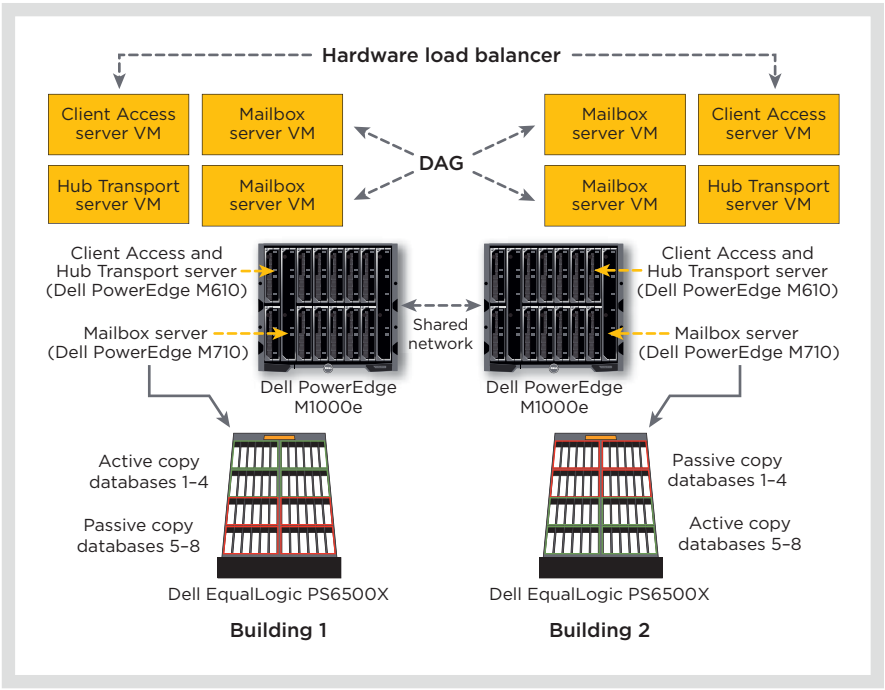

Figure 1. *Agile consolidated model: 10,000-mailbox Exchange Server 2010 reference architecture*

CONFIGURING EXCHANGE SERVER 2010

To help organizations design a Microsoft Exchange Server 2010 infrastructure that is well suited to their size and needs, Dell has created three architecture models that utilize recent advances in Dell server and storage technology to help simplify Exchange messaging environments. Each architecture model is designed to meet general requirements for Exchange platforms ranging from small and branch office deployments to large, enterprise-scale environments. These three architecture models provide a basic framework to help organizations design their own environments; IT managers can use the online Dell Exchange 2010 Advisor tool with its Web browser–based interface to assess size and capability needs and create a custom solution to meet specific organizational requirements.

Agile consolidated model

For large organizations primarily interested in enhancing efficiency and reducing costs through consolidation and standardization, Dell offers the agile consolidated model. By leveraging centralization, virtualization, and storage-based snapshots, this model is designed for robust, efficient, high-performing, and highly available and recoverable Exchange Server 2010 deployments. In particular, the agile consolidated model combines 11th-generation Dell PowerEdge rack and blade servers and Dell EqualLogic PS Series iSCSI SANs or Dell/EMC CX4 Series SANs with virtualization to enhance resource utilization, efficiency, and manageability.

To illustrate a typical Exchange deployment based on the agile consolidated model, Dell created a reference architecture designed to support a 10,000-mailbox campus Exchange Server 2010 environment (see Figure 1). If campus redundancy is not desired, a single blade enclosure and Hub Transport/Client Access blade can be used.

[1] Based on SPECfp_rate2006 benchmark tests performed by Dell Labs in June 2009 on a Dell PowerEdge R710 server with two quad-core Intel Xeon X5570 processors at 2.93 GHz and 48 GB of RAM, compared against August 2007 tests performed on a Dell PowerEdge 2950 server with two quad-core Intel Xeon X5365 processors at 3.00 GHz and 16 GB of RAM. For complete details, visit www.spec.org/cpu2006/results/rfp2006.html.

In Exchange Server 2010, server failover clustering is replaced with database availability groups (DAGs), which allows for more rapid failover than in previous versions with no need for soft recovery or crash recovery. This feature provides two separate logical stores of data so that erroneous writes emanating from one server do not affect the data used by the other server. It can also provide for nondisruptive planned site failover and minimally disruptive unplanned site failover, again avoiding the soft recovery process.

This reference architecture assumes a 1 GB average mailbox size limit and 0.14 I/Os per second (IOPS) per user (approximately 160 messages per day), and includes DAGs. It consists of two PowerEdge M1000e modular blade enclosures housing a total of two PowerEdge M710 blade servers, each with two quad-core Intel® Xeon® 5500 series processors and 144 GB of RAM. Each server is configured with either Microsoft Hyper-V™ or VMware® ESX virtualization software, and hosts two virtual machines (VMs) with four virtual processors (vCPUs) and 64 GB of virtual RAM running Exchange Server 2010. By virtualizing the Exchange servers into VMs and running them on advanced storage, organizations can take advantage of advanced protection techniques such as hardware independence; replication of VMs; snapshots; clones; rapid recovery of operating systems, applications, and data; and other features provided by SAN and virtualization integration. If site failover is to be automatic, it is important to have a third building (not shown) hosting the witness server, and that the connection leading to the third building be well isolated from the connection going to the second building.

Each site also houses one PowerEdge M610 blade server, configured with two quad-core Intel Xeon 5500 series processors, 48 GB of RAM, and either Microsoft Hyper-V or VMware ESX virtualization software. Each server hosts a Client Access VM with two vCPUs and 8 GB of virtual RAM as well as a Hub Transport VM with two vCPUs and 12 GB of virtual RAM.

For storage, the reference architecture utilizes two EqualLogic PS6500X iSCSI SANs. Each SAN includes forty-eight 600 GB, 10,000 rpm SAS drives in a RAID-50 configuration, with four active and four passive database volumes per server, 1,250 mailboxes per database volume, and room for 25 percent growth in database size. The two arrays allow comprehensive redundancy (both logical and physical) using Exchange DAG replication, which provides automatic failover to the other server and array.

An Exchange infrastructure based on the agile consolidated model can enhance efficiency and cost-effectiveness in several ways. For example, by consolidating processing power and storage into reduced form factors—11th-generation PowerEdge blade servers are designed to offer the same processing power as comparable rack and tower servers in a condensed form factor, and EqualLogic PS6500X iSCSI SANs are designed to offer outstanding density, supporting up to forty-eight 3.5-inch hard drives in a 4U enclosure—organizations can significantly enhance data center space efficiency. Also, because 11th-generation PowerEdge blade servers are designed to consume significantly less power than 10th-generation PowerEdge servers, they enable organizations to enhance energy efficiency as well. The Dell EqualLogic PS Series arrays also come standard with a comprehensive suite of software including snapshots, clones, replication, and other integration tools for simple protection and management of the environment.

Simple distributed model

For organizations interested in simplicity and ease of management, Dell offers the simple distributed model. The model leverages the high-availability and disaster recovery features native to Exchange Server 2010 to help deliver robust, highly available Exchange environments in a simple, cost-effective manner. In particular, the simple distributed model utilizes all-in-one server and storage "bricks" that can be combined to cost-effectively deliver performance and high availability. A brick can be either a single storage-dense rack server such as the Dell PowerEdge R510, or a rack server with DAS such as the Dell PowerVault MD1200 enclosure.

To illustrate a typical deployment based on the simple distributed model, Dell created a reference architecture designed to support a 10,000-mailbox Exchange Server 2010 environment with three DAGs (see Figure 2). This reference architecture assumes a 2 GB average mailbox size limit and 0.1 IOPS per user (approximately 100 messages per day). It consists of six PowerEdge R510 servers, each with two quad-core Intel Xeon 5500 series processors, 48 GB of RAM, and two internal 146 GB, 10,000 rpm, 2.5-inch SAS drives (in a FlexBay drive cage) in a RAID-1 configuration running the Microsoft Windows Server® 2008 R2 OS. Each server is configured with Mailbox, Client Access, and Hub Transport server roles (see Figure 2).

For the Exchange database and logs, each server contains 12 internal 2 TB, 7,200 rpm, 3.5-inch nearline SAS drives.

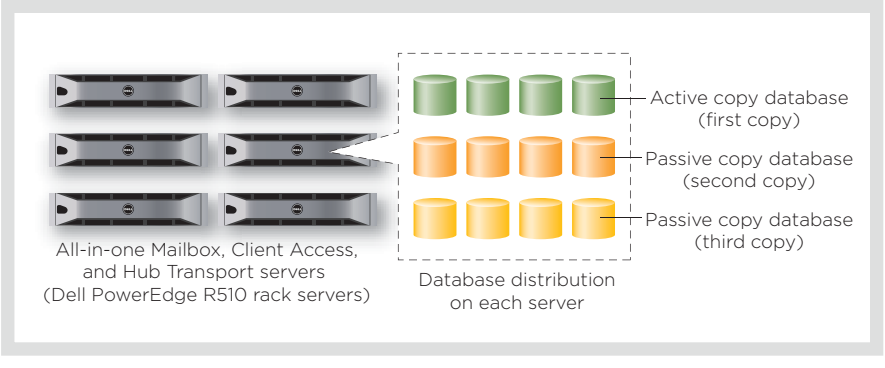

Figure 2. *Simple distributed model: 10,000-mailbox Exchange Server 2010 reference architecture*

One database is deployed on each disk, with 24 active databases and 48 passive databases deployed across the 72 disks. Each database has three copies, with each copy on a different server. Twelve databases reside on each server; the database and logs are combined on each disk. This configuration allows for 420 mailboxes per database, with a 2 GB capacity per mailbox and 36 percent estimated storage capacity available for growth.

By taking advantage of the high-availability features built into Exchange Server 2010, the simple distributed model provides extremely robust availability and failover capabilities with minimal management overhead. Also, by utilizing all-in-one server and storage bricks, the simple distributed model allows organizations to take advantage of the enhanced density of the PowerEdge R510 rack server or the scalability of using PowerEdge R710 rack servers combined with one or more PowerVault MD1200 storage arrays. The PowerVault MD1200 has twelve 3.5-inch SAS drives in a 2U chassis, with the option to daisy-chain multiple arrays together.

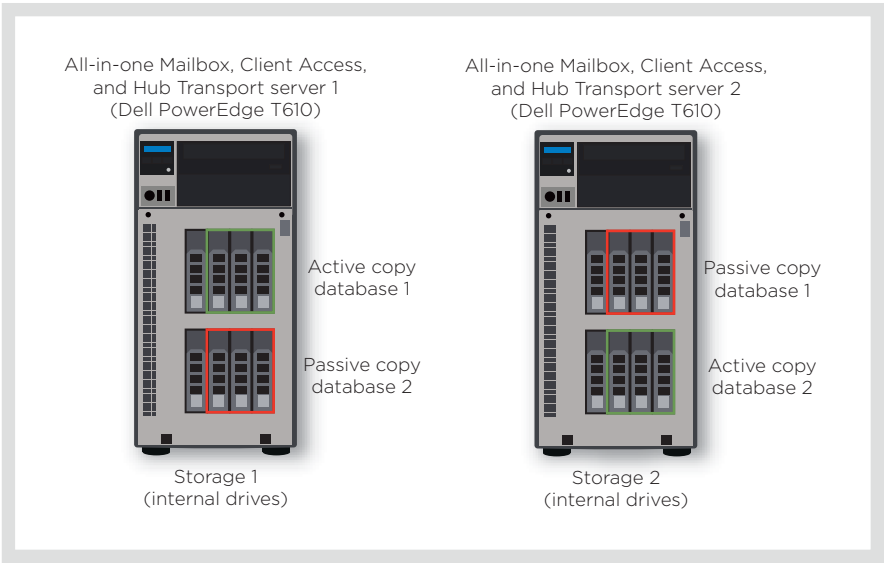

Figure 3. *Small and branch office model: 1,000-mailbox Exchange Server 2010 reference architecture*

Small and branch office model

For small and midsize organizations, Dell offers the small and branch office model. This model leverages individual tower or rack servers such as the Dell PowerEdge T610 to help provide reliable, fully redundant Exchange Server 2010 environments for Mailbox, Client Access (hardware-based IP load balancing assumed), and Hub Transport server roles. This redundancy enhances cost-effective data protection in Exchange Server 2010 when compared with previous versions of the Exchange messaging platform.

To illustrate a typical deployment based on the small and branch office model, Dell created a reference architecture designed to support a 1,000-mailbox Exchange Server 2010 environment (see Figure 3). This reference architecture assumes a 1 GB average mailbox size limit and 0.14 IOPS per user (approximately 160 messages per day). It consists of two PowerEdge T610 tower servers, each configured with two dual-core Intel Xeon 5500 series processors, 24 GB of RAM, and Windows Server 2008 R2. Each all-in-one server hosts the Exchange Server 2010 Mailbox, Client Access, and Hub Transport server roles.

For storage, each PowerEdge T610 server contains two internal 3.5-inch hard drives in a RAID-1 configuration for the OS, and six internal 3.5-inch hard drives for database and log storage. Each disk is a 600 GB, 10,000 rpm SAS drive with two sets in a RAID-5 configuration and with one active and one passive database per server, three database and log disks, 500 mailboxes per database volume, and a 25 percent estimated capacity for growth.

UNLOCKING THE POWER OF EXCHANGE SERVER 2010

The productivity and manageability features in Microsoft Exchange Server 2010, together with performance and efficiency advances in Dell servers and storage, offer enhanced value to end users and administrators alike. The three reference architectures explored in this article together with the Dell Exchange 2010 Advisor tool offer a starting point to help enterprises transition successfully to Exchange Server 2010. By building on best-practice configurations using 11th-generation Dell PowerEdge servers, Dell EqualLogic PS Series iSCSI SANs, Dell/EMC CX4 Series SANs, and Dell PowerVault DAS systems, administrators can tailor their messaging infrastructures to meet specific size and organizational requirements—helping to cost-effectively streamline management while enhancing overall enterprise efficiency and boosting user productivity.

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Stanley L. Stevens is a virtualization solutions marketing manager at Dell.

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ORACLE GRID COMPUTING: CHANGING THE WAY IT OPERATES

By Logan McLeod
Nathan Saunders
Thomas Kopec
Jaime Delgado

Grid computing has evolved rapidly from an appealing concept to an effective and critical real-world tool. Today, IT departments are using Oracle® grid architectures and Dell™ hardware to tackle some of the data center's most pressing problems, and keep IT closely aligned with dynamic business needs.

Today's IT departments must constantly adapt to rapid change while still maintaining high quality of service and responsiveness. And they must do so cost-effectively, even as workloads grow. Such challenges have put a tremendous strain on traditional data center architectures—and turned the attention of many IT departments to grid computing.

With grid computing, groups of hardware and software components are virtualized and pooled into a single set of shared services that can be rapidly provisioned and redistributed to help meet changing needs. The idea is to deliver flexible systems that are more resilient and less expensive than traditional legacy systems, which typically use dedicated servers to support database operations.

Efficiency and resilience are critical qualities for enterprise IT environments, and shared resources are therefore attractive to many of today's hard-pressed IT departments. As a result, grid computing has quickly gone from being an emerging architecture to a real-world approach employed by a large number of organizations. Oracle has been a pioneer in grid computing, having introduced its grid computing technologies in 2003, and there are now more than 15,000 organizations using Oracle grid technologies.

Oracle grid technologies and practices are an especially good fit with Dell technologies. Together, the two companies enable organizations to use sophisticated software and standard, cost-effective Dell servers and storage to create comprehensive grid infrastructures and efficient data centers. (For more on the Dell and Oracle relationship, see the "A common view of the grid" sidebar in this article.) With these infrastructures, many IT groups are changing the way they operate, and finding effective methods for keeping costs down, delivering high levels of performance, and staying aligned with the needs of the enterprise.

KEY ORACLE GRID SOLUTIONS

Grid computing can involve a variety of technologies. To help organizations create infrastructures that can meet their specific needs, Oracle offers a comprehensive, integrated portfolio of grid computing solutions reaching from the Web tier all the way down to middleware, databases, servers, and storage. Key solutions include the following:

- **Oracle Database 11*g*:** Oracle Database 11*g* delivers high levels of scalability and the ability to manage and maintain virtually all types of data online in a grid environment. The Automatic Storage Management feature creates a single pool of shared storage that can be provisioned on demand and automatically managed to help optimize

space utilization and avoid I/O bottlenecks. Workload management helps ensure that applications receive the processing resources needed to meet defined service levels. Streams and transportable tablespaces enable organizations to provision data as a resource on an enterprise-wide basis.

- **Oracle Real Application Clusters (Oracle RAC):** Oracle RAC enables a single database to run across a cluster of servers, helping avoid single points of failure and enabling administrators to scale the deployment incrementally by adding nodes as workloads increase. Thus, Oracle RAC helps provide high levels of fault tolerance, performance, and scalability without requiring application changes.
- **Oracle Enterprise Manager:** Oracle Enterprise Manager provides a single integrated interface for the top-down administration and monitoring of applications and systems in an Oracle grid. It continuously monitors resource allocation and utilization, and automatically provides alerts and takes corrective action whenever defined service levels are at risk because of capacity overload or failure. Enterprise Manager supports the broad Oracle ecosystem in a grid environment through a variety of connector and adapter plug-ins to third-party technologies and software.
- **Oracle VM:** Oracle VM is server virtualization software that helps maximize the consolidation and agility of x86- and x86-64-based systems in data center production environments. Administrators can manage resources centrally through an easy-to-use Web browser–based tool that enables them to create, clone, share, configure, boot, and migrate virtual machines. Oracle VM supports both Oracle and non-Oracle applications.
- **Oracle Fusion Middleware:** Oracle Fusion Middleware comprises a range of application grid products—such as WebLogic Server, Coherence, JRockit,

A COMMON VIEW OF THE GRID

In this interview, Dell CIO Robin Johnson and Oracle senior vice president of product development Angelo Pruscino discuss the Dell and Oracle relationship and how it has helped each company develop its approach to grid computing. For an extended podcast discussion between Johnson and Pruscino, visit www.oracle.com/goto/racpodcast.

WHAT DOES THE COMBINATION OF DELL AND ORACLE BRING TO GRID INFRASTRUCTURES?

"Both our companies emphasize simplified, cost-effective infrastructures, and that emphasis comes together in grid computing," says Johnson. "You can keep complexity and cost down by utilizing standards-based Dell servers and storage, while the Oracle grid architecture provides an easy-to-manage, flexible, available, and scalable grid environment on top of that. Our technologies go hand in hand."

Pruscino explains further: "One indication of that is the range of validated and tested configurations of Oracle and Dell technologies—including servers and storage—across the application, middleware, and database tiers. In general, these things are the result of a long relationship between Oracle and Dell."

WHAT DOES THAT RELATIONSHIP INVOLVE, AND HOW HAS IT AFFECTED THE EVOLUTION OF GRID COMPUTING?

"This is a multifaceted relationship," Johnson notes. "We have a very strong sales and marketing relationship, and Dell is a leading reseller of Oracle products across the entire product stack. But there is also a strong technology-focused relationship, and we work together on that front all the time."

"Oracle software is stress-tested and benchmarked on Dell hardware, and Dell often provides input for product modifications," says Pruscino. "In addition, we have also worked together on a number of targeted initiatives. One of these was Project MegaGrid, where our two companies and Intel partnered to develop a single validated set of deployment practices for grid computing. And there are others, such as Oracle Enterprise Management, where we joined forces to build a reference configuration that integrates Oracle Enterprise Manager with Dell OpenManage™ software, creating a powerful tool for managing an Oracle grid on Dell PowerEdge servers."

DOES THE FACT THAT DELL AND ORACLE ARE EACH OTHER'S CUSTOMERS HAVE AN IMPACT ON YOUR APPROACH TO GRID COMPUTING?

"Certainly," says Johnson. "Dell made a corporate decision to move over to a grid-type architecture, and Oracle has been a big part of that. We use Oracle Database, Oracle RAC and Oracle Applications, and Oracle Middleware. We are often involved in a lot of the early adopter and beta programs, which is a benefit to us. And Oracle gets Dell IT, this 5,000-plus-person enterprise, to help drive early adoption and improvements of the product."

Pruscino adds Oracle's perspective: "Oracle is a significant Dell user. We have 20,000 servers internally. We use Dell hardware for our hosting systems and our development systems, as well as other areas. That gives us a real working knowledge of how Oracle software and Dell hardware fit best together."

"The mutual customer relationships help us both run our businesses," Johnson concludes. "But it also means that our joint customers benefit from knowing that the solution stack we offer has already gone through the test of running in a world-class, Fortune® 50 organization."

and Tuxedo—that form the foundation for grid computing in the middle tier. With advanced clustering technology, these products support extremely high levels of availability, performance, and scalability. The ability to dynamically adjust cluster sizes of live running applications coupled with versatile automation helps provide efficient resource utilization and simplified management.

- **Oracle Enterprise Linux® OS:** Oracle Enterprise Linux is available as open source and is designed for comprehensive compatibility—both source and binary—with Red Hat® Enterprise Linux. Oracle Enterprise Linux is certified for compliance with the Linux Standard Base (LSB) standard, which helps to reduce the differences between individual Linux distributions and the costs involved in porting applications to different distributions, in addition to helping lower the cost and effort involved in supporting those applications. The Oracle Unbreakable Linux support program delivers cost-effective, enterprise-class support for Linux with premier backports, comprehensive management, indemnification, testing, and more.

ORACLE AND DELL GRID TECHNOLOGIES AT WORK

As grid computing finds its way into an increasing number of data centers, it is proving to be an effective tool in the effort to increase agility, simplify infrastructures, and, especially, consolidate IT resources. This was certainly the case at the State University of New York (SUNY), where the university, Dell, and Oracle worked together on a university-wide proof-of-concept project focusing on grid computing. The team consolidated 10 of the university's high-volume application systems into a single grid made up of Dell PowerEdge™ servers, Dell/EMC storage, and Oracle RAC software (see Figure 1, which shows the Oracle RAC cluster configuration used in this environment). The project showed that this grid infrastructure was effective in handling the multiple enterprise resource planning (ERP) applications and Oracle RAC databases, and that it could be dynamically scaled out to handle the needs of multiple large campuses—which is especially important for SUNY, which operates across 64 locations. The grid configuration was able to provide sub-second response times for a user load representing about 11,000 students simultaneously registering for classes and performing other typical tasks. In one test, nearly 70,000 courses were selected in an hour, which was about 37 times the actual number seen at a SUNY school of 11,000 students.[1]

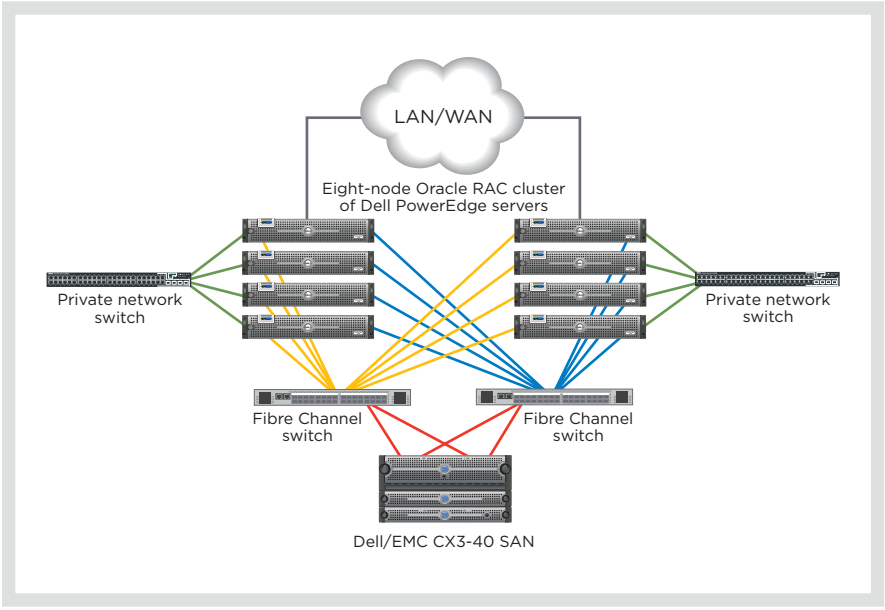

Figure 1. *Oracle RAC cluster configuration in the SUNY proof-of-concept environment*

One of the most extensive uses of Oracle and Dell grid technologies can be found at Dell itself. The Dell IT group was using the traditional approach of having dedicated servers running individual databases in its data centers. But as the business and data volumes grew, this approach became problematic, leading to server sprawl.

This traditional approach also made it difficult to keep up with demand. Each year, Dell IT typically handles about 600 projects that involve building database infrastructure. Each of those projects in turn typically requires disaster recovery systems and other environments, leaving each project with hundreds of gigabytes or even terabytes of storage attached. Delivering database infrastructure could potentially require two to three months, significantly reducing the value to the Dell business.

Matching computing power to actual demand was also a challenge. For each database environment, Dell IT was essentially required to forecast the necessary capacity. When the team would come back to these environments later, however, they often found that they had not been fully used: around 90 percent had been significantly overprovisioned and underutilized.

Too often, however, this fact became clear only months after the system was put in place. By then, from a provisioning and server logistics perspective, the Dell

[1] For more information on this testing and the proof-of-concept architecture, see "Scaling SunGard Higher Education Banner Software on Dell Hardware," by Dave Jaffe, Ph.D.; Kai Yu; and Dan Brint, in *Dell Power Solutions*, August 2008, DELL.COM/Downloads/Global/Power/ps3q08-20080283-SUNY.pdf.

> **"Oracle grid technologies and practices are an especially good fit with Dell technologies."**

team was left with underutilized storage area network (SAN) arrays in the middle of the data center that were difficult to reach, because the poles for the Fibre Channel cables were now too far from where servers were being added—making it difficult to reclaim those resources and leaving the storage effectively orphaned in the middle of the data center.

To help address the problem, Dell IT implemented a grid-based architecture that enabled the group to pool and share computing resources. The group then began pre-building computing capacity before requests for database infrastructure actually came in. This capacity, which took the form of 16-node Oracle RAC clusters of Dell PowerEdge servers with 10 TB of Dell/EMC SAN storage, enabled the group to move from a forecasting model to an on-demand model. Now, Dell IT can provision a massive amount of capacity up front, monitor consumption, and quickly reallocate or add resources as needed.

One result of this approach has been a reduction in provisioning time from 30 business days to just 5, with typical delivery in about 2. The grid architecture has also increased efficiency, helping ensure that computing resources are well utilized, while simultaneously increasing flexibility and enhancing the team's ability to rapidly respond to changing business demands.

The grid model has also led to significant savings: each 16-node grid enables Dell IT to avoid the installation of 134 physical servers that would have been required in the legacy model. Further operational savings have come from the reduced database administrator and systems engineering time associated with the reduced number of servers. The advantages have been similar for the storage as well. For the first grid, Dell IT used the traditional storage forecasts and approved approximately 85 TB of storage. After nine months, that environment still had not consumed more than the initial 10 TB that was deployed—avoiding the need for about 75 TB of storage just for that one case.

Dell IT currently has seven 16-node grids in place, each handling 150 databases, and it continues to expand its grid architecture. The team has found that this approach makes highly efficient use of the available resources. At Dell, consolidated virtual environments are now the default for database infrastructure in non-production environments.

EFFICIENT, COST-EFFECTIVE ARCHITECTURE

As the experiences of SUNY and Dell show, Oracle technologies give IT groups the tools to build grid architectures on cost-effective Dell hardware platforms to help achieve a range of benefits. An effective grid architecture can enable successful consolidation and a highly efficient data center, which in turn can help reduce costs as well as energy use in support of environmentally conscious computing. It can help increase operational agility, with on-demand provisioning and proactive monitoring of grids. It can support predictable performance and scalability with clustering and virtualization employed throughout the technology stack. And it can enable increased availability and quality of service. In short, today's grid architectures have the potential to deliver real results in the data center, and to the enterprise as a whole.

Logan McLeod is a senior enterprise architect for Dell IT, where he is responsible for global database technology strategy and architecture supporting Dell IT internal operations. Logan has more than 15 years of IT experience, is an active member of key industry advisory boards, and was most recently recognized as *Oracle Magazine*'s Grid Control Architect of the Year for 2006.

Nathan Saunders is a member of the Dell Solutions Alliance and Marketing team. In his career he has co-marketed with Microsoft, Novell, Oracle, Red Hat, and SAP managing OEM products coordination, product and partner marketing, and services. Nathan has a B.S. from Norfolk State University and an M.B.A. from New Mexico State University, and has received a Systems Engineer Certificate from Electronic Data Systems.

Thomas Kopec is a senior technical account manager with Oracle. As a member of the Oracle/Dell Alliance team, he focuses on the technical aspects of the resale relationship, including presales activities, training, and running point between the Dell and Oracle engineering teams. For the last 12 years he has supported Oracle's technology offerings in the channel.

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

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DEMYSTIFYING DEDUPLICATION

By Joe Colucci
Kay Benaroch

Deduplication holds the promise of efficient storage and bandwidth utilization, accelerated backup and recovery, reduced costs, and more. Understanding how this technology fits into a comprehensive data management strategy and taking advantage of Dell Services consulting expertise can provide the first steps toward an optimized storage and backup environment.

Deduplication has been around for several years, but as organizations contend with rapid data growth and increasingly constrained IT budgets, this technology has risen to the top of many priority lists—holding the promise of efficient storage capacity and bandwidth utilization, accelerated backup and recovery, reduced costs, and other benefits. At the same time, however, deduplication is surrounded by confusing and even contradictory information from a myriad of sources.

By understanding the basics of deduplication and its place within an overall approach to data management, IT administrators can evaluate how it can help them address their own IT challenges. In addition to the comprehensive Dell™ portfolio of platforms, software, and services designed to optimize storage and backup environments (see the "Dell data protection and deduplication transform backup operations" sidebar in this article), Dell Services consulting teams can help organizations assess their current infrastructure and goals to determine whether deduplication can help meet their needs and, if so, how they can deploy it for maximum efficiency.

KEY DEDUPLICATION TECHNOLOGIES AND APPROACHES

Deduplication is the process of eliminating duplicate copies of data and replacing them with pointers to a single copy. It typically serves two main purposes: reducing the amount of storage capacity required to store data, and reducing the network bandwidth required for performing backups or replication. The deduplication process is applied to an entire file system or storage device, which is what primarily differentiates it from compression. Key elements of deduplication include the level of granularity (file-level or block-level deduplication) and where the deduplication occurs during the backup process (at the source client or at the storage target).

Currently, the dominant application for deduplication is backup storage, because of the repetitive nature of backup data. However, deduplication has also moved into other areas such as network attached storage (NAS) and archive storage, a trend that is likely to continue as the technology reaches maturity (see Figure 1).

File-level and block-level deduplication

Some deduplication processes examine files in their entirety to determine whether they are duplicates, which is referred to as *file-level deduplication* or *single-instance storage* (SIS); others break the data into blocks and try to find duplicates among the blocks, which is referred to as *block-level deduplication*. Block-level deduplication typically provides more granularity and a greater reduction in the amount of utilized

DELL DATA PROTECTION AND DEDUPLICATION TRANSFORM BACKUP OPERATIONS

Backup technologies are evolving in response to the pressures of growth, time, resources, and budgets. The Dell storage portfolio includes platforms, software, and services designed to optimize storage infrastructures, simplify backup processes, and reduce the demand for scarce resources, including the following:

- **Dell NX4:** The Dell NX4 network attached storage (NAS) array incorporates a single-instance storage (SIS) methodology designed to optimize storage efficiency and reduce backup sizes by eliminating duplicate copies of files from Network Data Management Protocol (NDMP) backups.
- **Dell EqualLogic™ PS Series:** Protecting data at the primary level is an integral part of the Dell EqualLogic PS Series of Internet SCSI (iSCSI) storage area network (SAN) arrays, which includes software to automatically create snapshots, clones, and replicas of files at the primary, application, and virtual volume levels. Snapshots of data volumes used with backup software help relieve processing burdens from production servers by moving backups off the host server. Application-specific data stores and virtual machines can be protected using the EqualLogic Auto-Snapshot Manager / Microsoft Edition and EqualLogic Auto-Snapshot Manager / VMware Edition software integrated into the EqualLogic arrays.
- **Dell PowerVault™ DL2100:** The Dell PowerVault DL2100 data backup and recovery solution provides efficient backups in a single appliance through an integrated system of server, iSCSI storage, and CommVault® or Symantec™ backup software. The PowerVault DL2100 – Powered by CommVault incorporates advanced deduplication technology to deliver one of the industry's first block-level deduplication solutions for backup and archiving on disk and tape. When used in remote or branch office environments, this appliance can dramatically reduce the demand for backup replication network bandwidth, helping to make the backup process much more effective and efficient than it would be otherwise.
- **Dell/EMC CX4 Series:** Strong data protection and high performance are central features of Dell/EMC CX4 multi-protocol (Fibre Channel and iSCSI) storage arrays, which utilize software such as the EMC® SnapView™, MirrorView™, RecoverPoint™, and NetWorker™ applications to help quickly and flexibly recover from data loss or corruption. EMC NetWorker provides a heterogeneous layer of management and control for backup processes and media from a single interface and is designed to bridge the gap between traditional and next-generation backup. The latest aspects of deduplication can also be incorporated into Dell/EMC SANs using EMC's Disk Library, Avamar, and Data Domain products for source- or target-based data reduction, which offer the versatility, speed, and scalability to help ensure comprehensive data retention, replication, and recovery.

Dell Services teams can help organizations assess their data, environment, and requirements to identify and deploy appropriate storage systems as part of a comprehensive Intelligent Data Management strategy. For more information, visit DELL.COM/ICS.

storage capacity compared with file-level deduplication. Some deduplication software attempts to increase this efficiency even further by varying the size of the blocks to help locate additional commonalities, an approach known as *variable-block deduplication*.

Block-level deduplication is typically used for backup storage, but is not typically used with NAS or archiving systems because of the performance impact of the extreme disk fragmentation that block-level deduplication causes by its nature. File-level deduplication, however, can provide significant advantages for NAS. User home directories offer an excellent use case: multiple users often store the same documents or spreadsheets in their home directories. The Microsoft® Windows® Storage Server 2008 platform includes a SIS deduplication feature specifically for this purpose. This

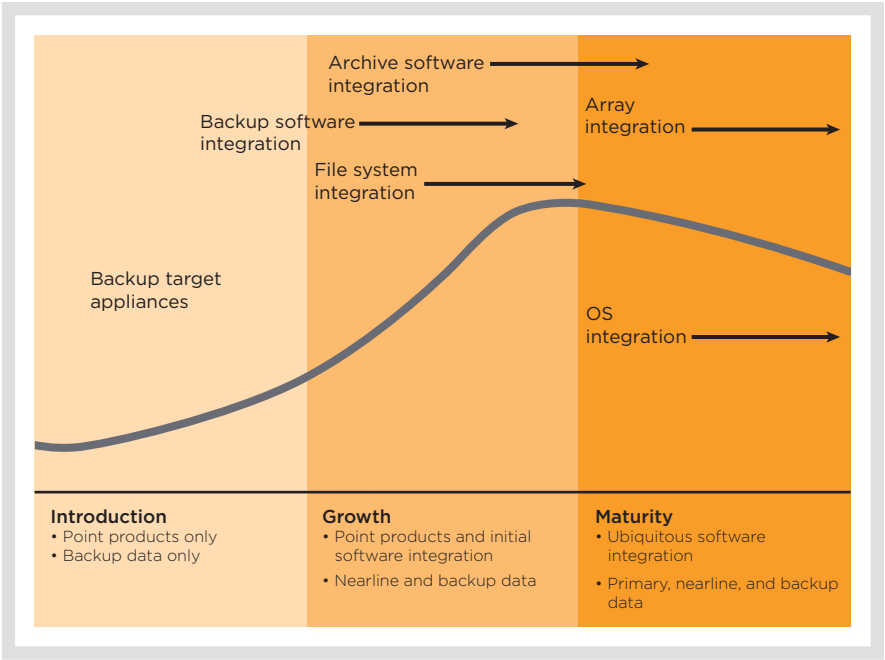

Figure 1. *Deduplication technology life cycle*

> **"Deduplication can be a highly effective data management tool—but it is not the only data management tool."**

feature retains a single copy of a file in a SIS common store and replaces duplicate copies with file system links, all performed transparently to end users.

Microsoft states that it is not uncommon to recover 25–40 percent of existing disk space after a Windows Storage Server 2008 SIS file consolidation has completed.[1] Because backup sizes are reduced for SIS-aware backup solutions, this approach can also help accelerate backup and recovery processes. The Dell NX4 storage system provides file-level deduplication with functionality similar to the Microsoft SIS feature, which can also help reduce backup sizes when using Network Data Management Protocol (NDMP).

Source and target deduplication

Deduplication can occur at two points in the backup process: at the source or at the target. Each type has its own advantages and disadvantages. In *source deduplication*, the deduplication occurs on the host that is being backed up, which helps significantly reduce the amount of data transferred over the network during a backup. By reducing the amount of network traffic, it can also alleviate network bottleneck conditions as well as issues related to backing up over a wide area network (WAN) link. The trade-off, however, is that this approach uses processor cycles on the backup client itself, which may be undesirable for production servers. More important is that until recently, many source deduplication solutions did not integrate well (if at all) into existing backup environments.

In *target deduplication*, the deduplication occurs on the backup storage itself. This approach does not reduce the network traffic during the backup, but can help do so when data is replicated off-site for disaster recovery. Target deduplication also avoids using system resources on the backup client. Target deduplication appliances can be a good option because they are generally easier to integrate into existing backup environments than source deduplication solutions.

Target deduplication solutions can use either *in-line* or *post-process* deduplication. In-line deduplication means that the data is deduplicated before it is actually written to disk. This approach requires only enough free space to write the changed data, but does require system resources on the appliance during the backup to identify the duplicate data. As processor power and cache sizes have increased, however, this effect has become less significant than it was in the past.

Post-process deduplication writes the backup data in its entirety, and then later deduplicates it as a batch process. The advantage of this approach is that the deduplication process does not affect the write performance during backups. The trade-off is that the storage target must have enough free space to write the entire backup set prior to deduplication—which can negate some of the cost benefit that is typically a primary driver for implementing deduplication.

DISK VERSUS TAPE FOR BACKUP STORAGE

Traditionally, tape has been the most cost-effective medium for backup data storage. However, the operational characteristics of tape devices are also the source of many common backup challenges. Mechanical failures are generally much more common in tape libraries than they are in disk devices because of the physical movement and loading of tapes: robotic arms can fail to align tapes properly and tape leaders can break. Both of these issues can result in a tape stuck in a drive—which then has a cascading effect on the rest of the backup cycle. When these failures occur, the result is often unprotected data and backup administrators being paged in the middle of the night.

Another major challenge is related to performance. Tape drives have a minimum threshold for the rate at which they receive data to keep the tape streaming, or moving constantly. For Linear Tape-Open Ultrium 3 (LTO-3) and LTO-4 technology, this minimum threshold is specified at 27 MB/sec; if this threshold is not met, the tape drive must stop the tape, rewind, and then continue writing. When this process happens repeatedly, it is known as *shoe shining*, because the movement of tape back and forth across the tape head resembles that of a rag shining a shoe. Shoe shining can further reduce backup performance and cause excessive wear and premature failure of tapes and drives. Backups over slow WAN links are particularly susceptible to these problems, often forcing organizations to place tape devices at remote locations where they do not have staff to support them. Whereas in the past, the throughput of the tape drives was a performance limitation, the current challenge is typically to feed data to the tape drives at a fast enough rate.

In response to exponential growth in data volumes, tape manufacturers have scaled the capacity and performance of tapes and drives—but as this capacity and performance have increased, so too have the minimum data rates. Because backups typically send data over a network to a media server, network bottlenecks are a common performance inhibitor in enterprise backup configurations: media servers often manage numerous tape drives, yet

[1] See www.microsoft.com/windowsserver2008/en/us/wss08/sis.aspx.

the environment may not provide enough throughput to maximize the performance of even a single drive. Upgrading or deploying additional tape devices to help address performance issues generally only exacerbates the situation.

Finally, tape devices are often inefficient for small backup or recovery jobs, because more time is spent loading, positioning, and unloading the tape than is spent actually reading or writing data.

These issues, along with the overhead of media management, mean that disk is often a more attractive media than tape for backup storage—particularly as disk densities have increased while cost has decreased. Disk devices cannot solve a network bottleneck problem, but because they do not require a minimum data rate to work efficiently, they do not suffer the same ill effects as tape in relation to these bottlenecks. The reduced number of moving parts and support for RAID also typically make disks more reliable than tape.

One of the traditional strongholds for tape has been off-site backup storage for disaster recovery. The bandwidth necessary to replicate backup data often makes replication impractical for anything but business-critical data, which has left shipping tapes off-site as one of the few options for protecting data against damage to the site itself. Because block-level deduplication writes only blocks that have changed since the previous backup, the reduction in capacity and bandwidth requirements for backup data can help further narrow the cost gap between disk and tape—making disk a practical option for local backup storage and making replication a practical option for off-site backup storage (see Figure 2). Other advantages include helping to reduce disk capacity, bandwidth, power, cooling, and space requirements; accelerate recovery times and increase availability; and centralize data protection and archiving processes. These benefits can make it possible to eliminate tape in more instances (if not completely) than was previously possible.

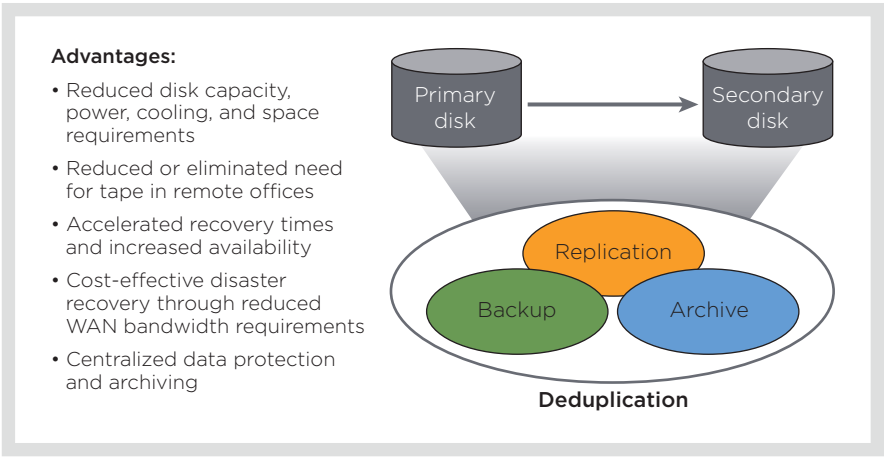

Figure 2. *Cost-effective backup to disk through deduplication*

DEDUPLICATION RATIO

The deduplication ratio is typically used in backup environments to measure how much a deduplication solution can reduce the amount of storage consumed. A 20:1 ratio, for example, means that storage consumption is reduced by 95 percent. However, this ratio does not necessarily mean that administrators can now store 20 times as much data on a disk. For example, if the original data set is 500 GB, this ratio does not mean that they can now store that same 500 GB in 25 GB. Instead, it means that they could likely retain multiple backup versions of that 500 GB in much less space—for example, using only 525 GB for five versions rather than 2.5 TB.

Exact deduplication ratios are generally difficult to predict, because they must account for multiple variables. In addition to the algorithms used in the deduplication process, the ratio can be affected by data change rates, data types, the mix of full or incremental backups, and retention periods, any or all of which may differ even within a single environment. In addition, software that measures data change rates typically can track only the number of files changed, not the amount of data within each file that was changed. Tools to predict a deduplication ratio should generally be used only for estimated sizing.

FILE TYPE

File type does not have an effect on file-level deduplication. When using block-level deduplication in a backup environment, however, administrators should keep in mind that some file formats may deduplicate better than others. Deduplication solutions typically find duplicate data in two scenarios: when the same files are backed up more than once, and when duplicate data is found within a given data set. For example, when backing up a user share, deduplication solutions are likely to find duplicate data on the first backup, because multiple users may have saved the same file or modified versions of the same file. Organizations can gain significant savings on backup disk usage even on the first backup when this type of duplication is present.

"When considering a deduplication solution, it is important to evaluate the specific environment and set clearly defined requirements."

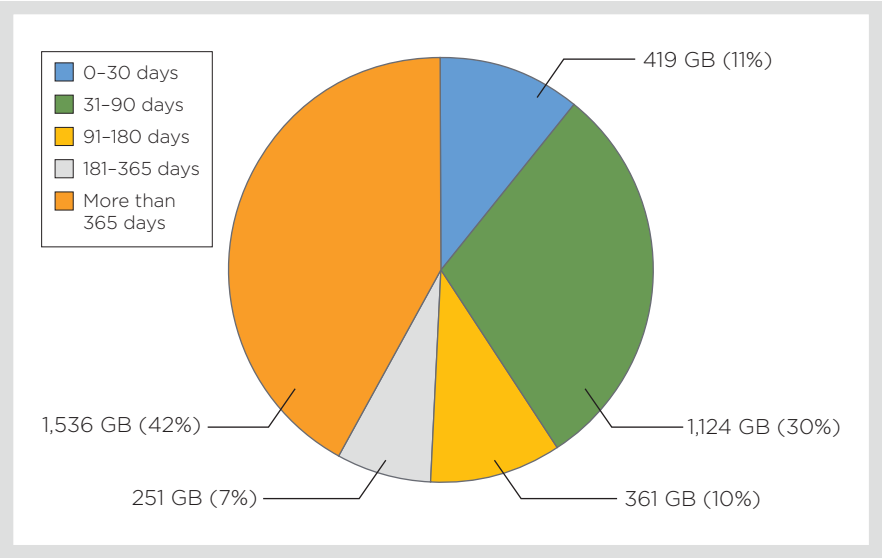

Figure 3. *Dell Services change analysis of file modification dates in a real-world environment*

Microsoft Office files tend to deduplicate well on the block level, because they often have overlapping content: there are only so many words in the dictionary, and some words are much more common than others. Compressed or media files, in contrast, tend to deduplicate less well, because they can have a much wider range of values.

Data that has a high change rate tends not to benefit as much from either type of deduplication as data with a lower change rate. In backup environments, backup data with a long retention period tends to benefit more from deduplication than data with a shorter retention period.

DELL SERVICES AND COMPREHENSIVE DATA MANAGEMENT

Deduplication can be a highly effective data management tool—but it is not the only data management tool. Dell views deduplication as part an overall data management strategy rather than as a solution in itself, and therefore includes deduplication as part of its backup, recovery, and archiving services rather than as a standalone service.

Deduplication can help address many challenges, especially in a backup environment. However, approaching a specific problem from a narrow perspective may not lead to the best solution. Figure 3, for example, shows a change analysis performed during a real-world Dell Services engagement. At the time this sample was taken, 42 percent of the organization's 3,691 GB of data had not been modified in over a year. If the Dell team were focused solely on deduplication, this would appear to be a good use case. However, when considering an overall strategy, this environment could be better suited for an archiving system—perhaps in addition to deduplication.

The Dell Data Management consulting team can perform an analysis on an organization's data, IT environment, and requirements to help determine whether deduplication is a good option and, if so, which solution is best suited to that organization. Partnerships with deduplication industry leaders enable Dell to select a best-of-breed product as part of a comprehensive solution for specific enterprise needs.

DEDUPLICATION AND STORAGE EFFICIENCY

When considering a deduplication solution, it is important to evaluate the specific environment and set clearly defined requirements. Is network bandwidth during the backup process a problem? Do backup processes run over a WAN or a slow network connection? Does the data need to be retained for long periods of time? Understanding the needs of the organization goes a long way toward identifying a solution that can effectively address those needs. In addition, organizations should evaluate how individual products are implemented and how easily they can integrate into the existing environment—considerations that are more important than a deduplication ratio.

Finally, deduplication should be deployed as part of an overall Intelligent Data Management strategy that also includes archiving and storage tiering considerations. Dell Services can help organizations create this type of strategy and identify where deduplication fits in to help maximize efficiency in their storage and backup environments.

Joe Colucci is a global solution architect on the Dell Global Infrastructure Consulting Services Data Management team. He has 15 years of IT experience, including 10 in storage consulting. He has a bachelor's degree in Computer Science from Lehigh University.

Kay Benaroch is a marketing senior consultant in the Dell Storage Solutions organization responsible for data protection marketing activities.

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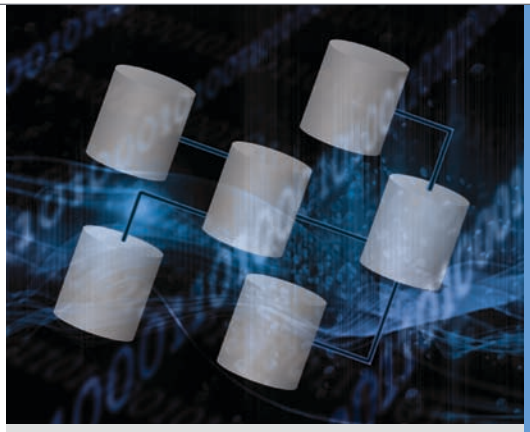
SIMPLIFYING MANAGEMENT THROUGH WINDOWS STORAGE CONSOLIDATION ON DELL POWERVAULT NX3000 NAS APPLIANCES



By Timothy Sherbak

Consolidating Microsoft® Windows® file shares into a common pool of network-accessible resources helps increase utilization, simplify management, and enhance service levels. Organizations can deploy scalable Dell™ PowerVault™ NX3000 Series network attached storage (NAS) appliances as stand-alone file servers or as gateways to storage area networks to enable reliable, efficient, high-performing Windows file share and application consolidation.

IT departments are spending ever-increasing resources to maintain current operating environments, reducing the discretionary budget allocation for new projects that advance innovation and achieve organizational goals. To help free up capital for innovation, many organizations are looking for ways to enhance the efficiency and manageability of current infrastructures. Storage consolidation is one key strategy many organizations are embracing.

Consolidating storage into a common pool of network-accessible resources helps organizations to not only increase efficiency and reduce costs, but enhance service levels as well. For example, because of the proliferation of Microsoft Windows–based servers in many organizations, simply migrating Windows storage and file services from individual servers to consolidated storage can boost resource utilization, streamline management, and enhance data protection and recovery operations.

Dell offers a comprehensive range of storage options that help organizations reap the benefits of storage consolidation. For example, the Dell PowerVault NX3000 Series of network attached storage (NAS) appliances is exceptionally well suited for consolidating storage in support of Windows file-sharing services at the departmental or enterprise level. The PowerVault NX3000 can be operated as a stand-alone file server, or it can be configured as a gateway to an enterprise-wide storage area network (SAN) such as a Dell EqualLogic™ PS Series Internet SCSI (iSCSI) SAN for large-scale environments.

Dell storage platforms have extensive storage efficiency, management, and availability features. Furthermore, Dell offers a broad selection of services to help organizations design, implement, and maintain storage consolidation solutions. In concert with Dell ProConsult assessment, design, and implementation services, these solutions help organizations enhance the efficiency and manageability of their enterprise storage infrastructures.

CONSOLIDATING ISLANDS OF WINDOWS STORAGE

Microsoft Windows–based servers are widespread in many organizations. Often, Windows storage—file system and application data—is deployed on local direct attach storage (DAS). Adding servers incrementally over the years can result in an ad hoc storage deployment that is often overprovisioned initially to help avoid the need for reprovisioning later. Rampant file-sharing services from across these resources can be problematic, resulting in a

proliferation of critical file-share data throughout the enterprise.

These islands of Windows storage are often inefficient and complex to manage, and can lead to high costs and application disruption as enterprise requirements evolve. Storage deployed on DAS is unavailable to other applications, which can lead to underutilization, and distributed "islands" of storage can present significant management challenges. Also, multiple points of failure complicate backup and recovery, making it difficult to ensure application availability.

One way to enhance the efficiency and manageability of Windows storage is through consolidation. Consolidation allows Windows file system and application data to be provisioned from a common pool of network-accessible storage, enabling high utilization, a single point of management, and significantly simplified backup and recovery. In a consolidated environment, unused storage is available for use by other applications, helping to increase resource utilization. And by aggregating critical data in a centralized location, a consolidated storage infrastructure enables increasingly efficient processes and strategic implementation of backup and recovery services.

The Dell PowerVault NX3000 NAS appliance provides an outstanding platform for consolidating Windows file-sharing services from the branch office to the entire enterprise. The PowerVault NX3000 is a high-performance, high-capacity, multiprotocol network appliance that supports multiple storage access protocols, including Server Message Block (SMB) 2.0, Network File System (NFS), FTP, and iSCSI as well as Gigabit Ethernet and 10 Gigabit Ethernet connectivity. The PowerVault NX3000 utilizes a range of industry-standard hardware and software, including Microsoft Windows Storage Server 2008 preconfigured as a file server and the Intel® Xeon® processor 5500 series architecture. In addition, the PowerVault NX3000 offers a range of features designed to facilitate installation and management, such as wizard-based deployment and configuration tools and Web browser–based remote management capabilities.

For environments serving up to several thousand users, a single PowerVault NX3000 NAS appliance can be easily and rapidly deployed as a departmental or small-organization file server (see Figure 1). In this scenario, user home directories and file shares are consolidated onto a centralized file server to help reduce capacity requirements and enhance storage utilization. The PowerVault NX3000 utilizes a native Windows-based infrastructure and integrates with Microsoft Active Directory® directory services as well as standard Windows-based data protection and antivirus tools and services.

A consolidated Windows file server environment based on the PowerVault NX3000 can enhance efficiency, manageability, and recoverability in several ways. Because storage is allocated from a single centralized pool, there is no need to overprovision storage for individual applications. Also, a single point of management helps avoid the need to manage individual file shares distributed on servers throughout the organization. Consolidated backup and advanced online user recovery features also enhance data protection and help simplify backup and recovery.

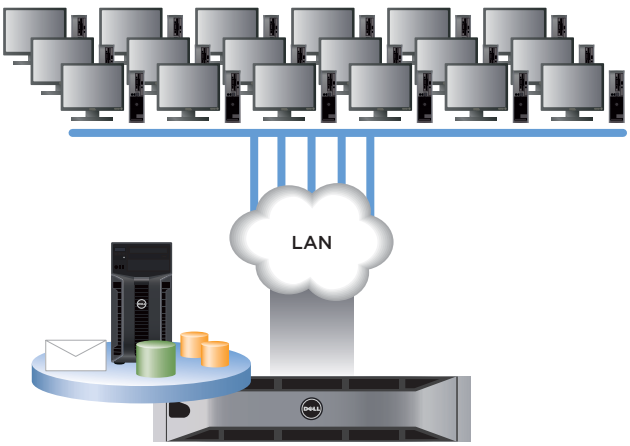


Figure 1. *Dell PowerVault NX3000 NAS appliance as a departmental file server*

LEVERAGING ADVANCED WINDOWS FILE SERVICES

The Dell PowerVault NX3000 NAS appliance utilizes the Microsoft Windows Storage Server 2008 platform, which has a range of features designed to improve efficiency and simplify manageability of Windows file-sharing services. These features include the following:

- **Single-instance storage (SIS):** SIS is an automated background file deduplication service that replaces multiple identical copies of a file with logical links to a single source copy. File-level deduplication is designed to be fully transparent to end users and applications, and can help save a significant amount of space. For example, Microsoft has stated that in its own internal SIS deployment across more than 200 file servers, it has reduced storage by 25–40 percent depending on the type of content stored.[1]
- **File Server Resource Manager:** File Server Resource Manager is a centralized, Web browser–based tool for

[1] For more information, see "Single Instance Storage in Microsoft Windows Storage Server 2003 R2: A Solution for Managing Duplicate Files," by Microsoft Corporation, February 2008, available at www.microsoft.com/downloads/details.aspx?displaylang=en&familyid=99f8ee58-4faf-4951-ba84-7237b5c639b5.

managing Windows file-sharing services. File Server Resource Manager includes comprehensive storage reporting features such as file-system-related reports for tracking granular storage utilization and on-demand and scheduled reports, support for quotas so organizations can limit excessive data growth through predefined policies, and file screening, which enables administrators to control the type of data stored on a share.

- **Rapid file recovery based on Shadow Copies for Shared Folders:** Rapid file recovery allows end users to recover previously erased files by themselves, without administrator intervention.
- **Support for Offline Files:** Users can maintain access to a local cached copy of their home directories regardless of whether they are connected to the network. Home directories are synchronized when users reconnect to the file share.
- **Distributed File System Namespaces (DFS-N):** For organizations deploying more than one physical file server, DFS-N provides a single logical view of file shares across multiple servers. With DFS-N, users connect to a single logical file server without needing to know where the underlying storage is physically deployed.
- **Distributed File System Replication (DFS-R):** DFS-R is designed to support advanced file services for remote offices. DFS-R replicates and synchronizes file shares across locations for high-availability access, disaster recovery, and centralized backup. It also helps minimize wide area network (WAN) traffic through remote differential compression and by replicating only changed blocks.

Because the PowerVault NX3000 is built using industry-standard hardware and software such as Windows Storage Server 2008, administrators can use familiar management and backup and recovery tools and do not have to learn specialized new platforms.

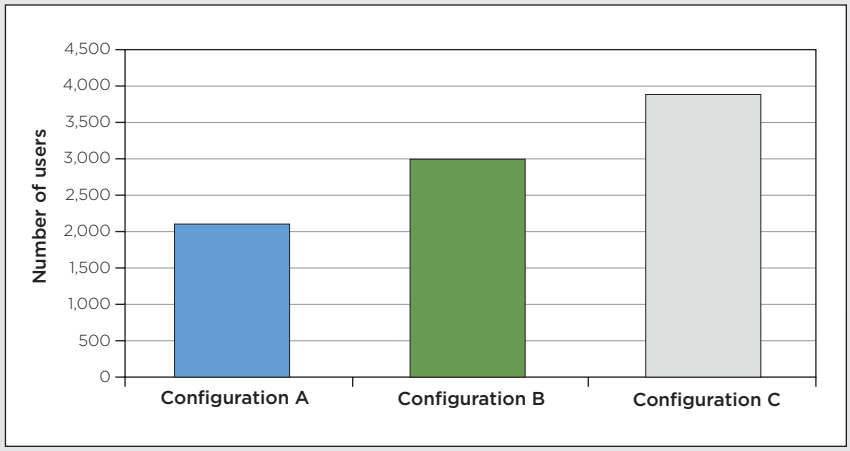


Figure A. *File service support for up to 4,000 users with a Dell PowerVault NX3000 NAS appliance and Dell EqualLogic PS Series iSCSI SAN*

BENCHMARKING DELL POWERVAULT NX3000 NAS FILE SERVER PERFORMANCE

In June 2009, Principled Technologies conducted a Dell-commissioned benchmark study to evaluate the performance of consolidated file services deployed on a Dell PowerVault NX3000 network attached storage (NAS) appliance and Dell EqualLogic PS Series Internet SCSI (iSCSI) storage area network (SAN) array. The tests utilized the Microsoft File Server Capacity Tool (FSCT), which is designed to help organizations both select new hardware and analyze the capacity and performance of hardware currently in place.

The test team used the FSCT HomeFolders workload, which simulates typical end-user file access activities initiated through common desktop applications such as Microsoft Office and Windows Explorer. Results provided by FSCT include the maximum number of users for a server configuration, throughput for a server configuration (measured in scenarios per second), and scenario response time.

Three storage configurations were benchmarked:

- **Configuration A:** A PowerVault NX3000 NAS appliance with one quad-core Intel Xeon L5520 processor and 3 GB of RAM connected to an EqualLogic PS4000E array with sixteen 1 TB, 7,200 rpm Serial ATA (SATA) hard drives in a RAID-50 configuration, for a total usable storage capacity of 10.4 TB
- **Configuration B:** A PowerVault NX3000 NAS appliance with one quad-core Intel Xeon L5520 processor and 3 GB of RAM connected to an EqualLogic PS4000E array with thirty-two 1 TB, 7,200 rpm SATA hard drives in a RAID-50 configuration, for a total usable storage capacity of 20.8 TB
- **Configuration C:** A PowerVault NX3000 NAS appliance with two quad-core Intel Xeon L5520 processors and 12 GB of RAM connected to two EqualLogic PS4000E arrays with thirty-two 1 TB, 7,200 rpm SATA hard drives in a RAID-50 configuration, for a total usable storage capacity of 20.8 TB

The results of this study indicated that a single PowerVault NX3000 NAS appliance connected to an EqualLogic iSCSI SAN can support the file service needs of up to 4,000 typical users (see Figure A). This type of configuration can be easily scaled to meet the file service needs of tens of thousands of users by adding PowerVault NX3000 NAS appliances.*

*For the complete report, including detailed information on the test environment, benchmark workloads, methodology, and results, see "File Server Performance Comparison of Three Dell PowerVault NX3000 Configurations Using Microsoft FSCT," by Principled Technologies, June 2009, www.principledtechnologies.com/clients/reports/dell/NX3000.pdf.

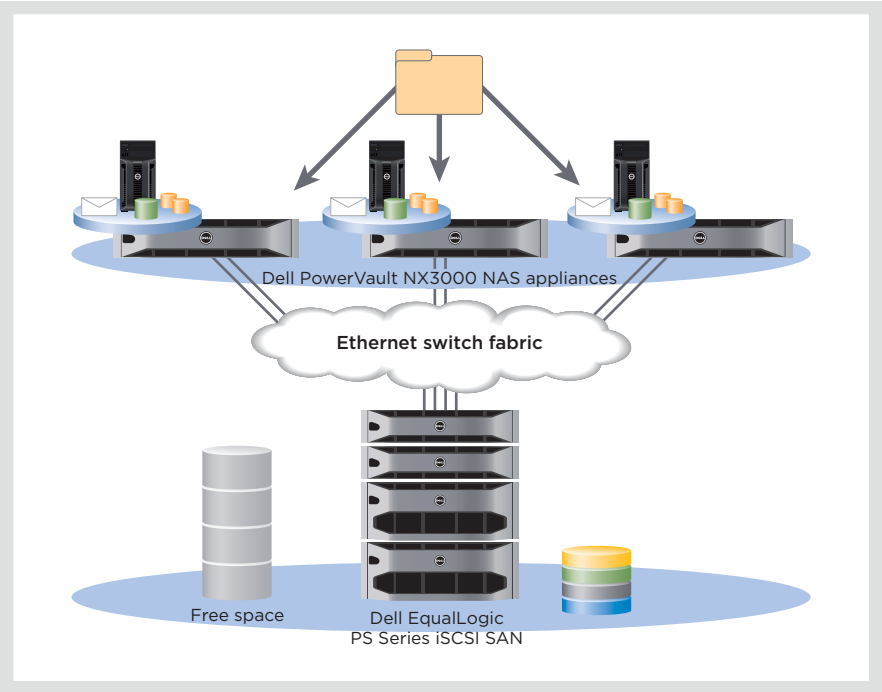


Figure 2. *Dell PowerVault NX3000 NAS appliances as gateways to a Dell EqualLogic PS Series iSCSI SAN*

EXTENDING STORAGE CONSOLIDATION ACROSS THE ENTERPRISE

To support Microsoft Windows storage consolidation in large environments, the Dell PowerVault NX3000 NAS appliance can also be used as a NAS gateway to a SAN. For example, to support an enterprise-scale consolidation of Windows storage, multiple PowerVault NX3000 file servers can be deployed as NAS gateways to a Dell EqualLogic PS Series iSCSI SAN (see Figure 2).

In this type of environment, file system storage for each file server is provisioned from a common pool of storage located on an EqualLogic SAN. Scalable DFS-N services enable a single logical namespace for end users, and storage growth can be accommodated through central provisioning from a common resource pool. Integrated SAN-based management tools included with EqualLogic arrays facilitate streamlined management, protection, and recovery.

The PowerVault NX3000 offers excellent performance and scalability. For example, a recent benchmark study showed that a single PowerVault NX3000 NAS appliance can support up to 4,000 typical users (see the "Benchmarking Dell PowerVault NX3000 NAS file server performance" sidebar in this article). To support environments scaled for more than 4,000 users, PowerVault NX3000 NAS appliances can be combined to support enterprise-scale deployments of up to tens of thousands of users.

An EqualLogic virtualized iSCSI SAN is an exceptionally well-suited complement to the PowerVault NX3000 NAS appliance, and can efficiently meet the large-capacity storage needs of enterprise-scale deployments simply, flexibly, and reliably. Features include industry-standard iSCSI connectivity, storage virtualization to help maximize utilization, automated load balancing, high performance, efficient scalability, extensive management and availability tools, and advanced integration with Windows Storage Server 2008. Key Microsoft integration features include Microsoft Multipath I/O (MPIO), which enables intelligent multipathing for high availability and performance, and EqualLogic Auto-Snapshot Manager/Microsoft Edition, which enables the simple creation of application-aware SAN snapshots for

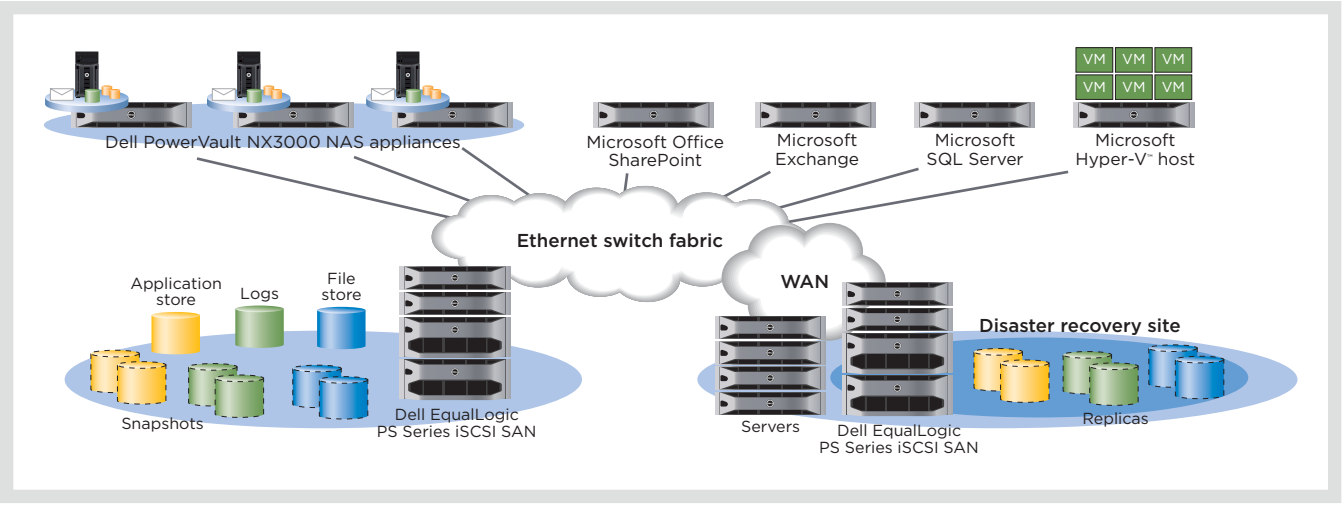


Figure 3. *Dell EqualLogic PS Series iSCSI SAN for Dell PowerVault NX3000–based file servers and Microsoft Windows–based server applications*

enhanced availability and recovery of Windows-based file systems and application data.

CREATING A UNIFIED STORAGE INFRASTRUCTURE

A consolidated storage infrastructure based on Dell PowerVault NX3000 NAS appliances and Dell EqualLogic PS Series iSCSI SANs can also support Microsoft Windows server environments beyond Windows file shares. For example, PowerVault NX3000–based file servers and other Windows-based servers—including 11th-generation Dell PowerEdge™ servers running a variety of applications, such as Microsoft Exchange, Microsoft SQL Server®, and Microsoft Office SharePoint® software—can concurrently access and utilize a single EqualLogic SAN (see Figure 3). In this scenario, Windows file share and application data are consolidated into a common scalable pool of storage resources located on the EqualLogic SAN. This approach enables organizations to consolidate their Windows infrastructure into a comprehensive, IP-based Windows server environment.

CONFIGURING DELL STORAGE FOR CONSOLIDATED WINDOWS INFRASTRUCTURE

Consolidating Microsoft Windows file shares and application data into a common pool of network-accessible storage helps organizations not only enhance utilization and efficiency but also simplify management and increase availability. Dell offers a broad range of storage solutions, including the Dell PowerVault NX3000 NAS appliance and Dell EqualLogic PS Series virtualized iSCSI SANs. In addition, comprehensive assessment, design, and implementation services help organizations successfully design and deploy a consolidated storage strategy for Windows server environments, enabling them to reap the tremendous benefits of consolidation.

Timothy Sherbak is senior manager of storage solutions marketing in the Dell Large Enterprise Business Unit.

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PROTECTING CRITICAL INFRASTRUCTURE AND MOBILE DATA: AN INFORMATION-CENTRIC SECURITY STRATEGY

By Annette Cormier
Mark Christenson
John McDonald

Sharing data among internal IT environments, mobile users, and applications or remote monitoring systems outside the firewall can expose organizations to multiple points of vulnerability. Dell, EMC, and RSA have teamed up to provide an efficient and flexible information-centric security strategy spanning the enterprise infrastructure from client laptops through applications and storage systems.

The ability to integrate and share data across multiple systems and networks is a necessity in today's data centers. Global IT command centers rely on merged networks, shared data, and rapid communications for IT operations, business intelligence, and emergency response. Web 2.0 technologies such as Twitter and blogs, combined with citizen journalists and mobile phones, are making it possible to enhance disaster response with rapid information sharing and levels of detail not previously available. Additionally, IT operations staff may need to connect their enterprise networks to separate networks, including plant-based process control networks (PCNs) and outsourced supplier networks for supply chain management and hosted e-business applications.

Efficient business intelligence and emergency operations often depend on hybrid networks that include a variety of technologies and protocols. These hybrids may bring together IP-based enterprise networks; satellite, voice, and video communication networks; PCNs used in utilities and chemical manufacturing for linking systems based on supervisory control and data acquisition (SCADA), human-machine interface (HMI) systems, and programmable logic controller (PLC) technologies; and wireless networking for remote mobile workers such as utility operators, field engineers, or military ground troops.

For example, many gas and electrical utility companies connect plant PCNs to business networks to enable efficient integrated management and accelerate the coordination of communications to restore plant shutdowns caused by natural disasters or turbine failures. Equipment manufacturers may connect business networks to supply chain automation solutions outside the firewall to share a common dashboard, to make rapid updates in pricing and inventory availability, or to facilitate commodity trading. Closed-circuit television is often transmitted wirelessly and utilized for monitoring traffic flows on highways, allowing visitors in zoos to observe newborn animals without disturbing them, and enhancing safety at public transportation facilities.

This connectivity enables increasingly efficient operations but can open up multiple points of vulnerability in the infrastructure, creating a complex set of security requirements. PCNs and legacy networks, in particular, are inherently insecure because of specialized infrastructures that cannot be patched or are too costly to replace. PCN vulnerability to cyberattacks could have devastating consequences—for example, endangering public health and safety if there is interruption in chemical processing or electric grid transmission. Many recognized security threats affect a variety of industries and individuals, including

organized e-fraud gangs, man-in-the-middle and zero-day attacks, and a host of other threats. And, of course, simply losing a laptop with confidential information can be highly detrimental.

DISCOVERING THE VULNERABILITIES OF THE CLOUD

New security challenges are now appearing in the computing cloud, such as hyperjacking, virtual machine jumping, and guest hopping. Malware projects such as SubVirt, virtual machine rootkits, and Blue Pill capitalize on virtualization technology to create an ultra-thin hypervisor that takes control of the underlying OS.

Adding to the security complexity of today's environments, organizations must also meet a growing number of standards to help protect confidential data. These standards include requirements from the Payment Card Industry Data Security Standard (PCI DSS), the U.S. National Institute of Standards and Technology (NIST), the U.S. Federal Energy Regulatory Commission/North American Electric Reliability Corporation (FERC/NERC), the Sarbanes-Oxley Act (SOX), and others.

At the same time, traditional perimeter security measures have reduced effectiveness, can be ineffective when zero-day attacks occur, and have become increasingly difficult to scale with the constantly evolving security attack vectors and universal expansion of information sharing across the enterprise and beyond the firewall.

SAFEGUARDING INFORMATION WHEREVER IT IS LOCATED

Taken together, these factors are driving many organizations to adopt an information-centric security approach designed to protect data at rest, data in motion, and data in use (see Figure 1). Solutions for security include verified launch and secure root of trust technologies, segmentation techniques, hardening of infrastructure and data, encryption, software patching, and solutions for monitoring and management. In addition, a backup of data is a minimum requirement to enable rapid recovery from downtime caused by a security breach.

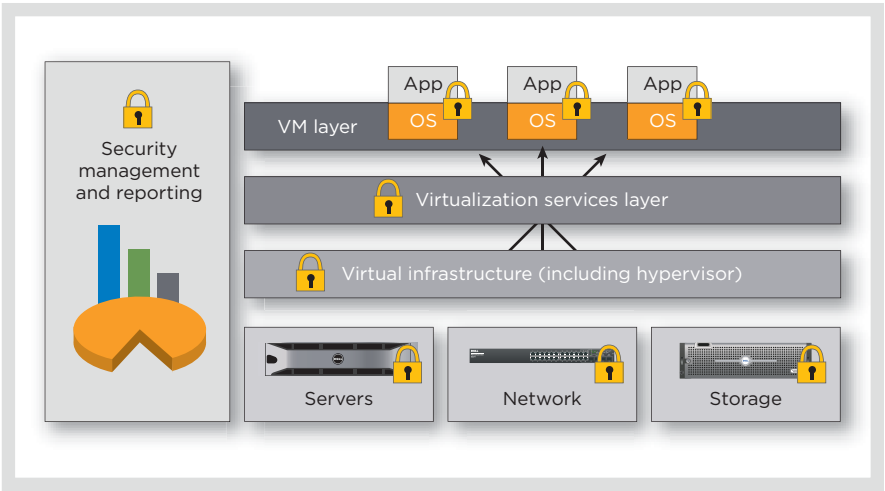

Figure 1. *Driving information security enforcement throughout the infrastructure*

Dell, EMC, and RSA have teamed up to deliver an information-centric security strategy that spans the infrastructure from client laptops, through network applications, to the storage systems where data ultimately resides at rest. In this multilayered model, Dell/EMC CX4 Series storage area network (SAN) arrays, Dell™ NX4 network attached storage (NAS) devices, and EMC® Celerra® unified storage systems provide storage-based security with extensive security certifications. EMC RecoverPoint™ data protection software offers automated backup and rapid recovery of data. EMC PowerPath® Encryption with RSA software and RSA security appliances provide host and application security and encryption. And client security features are provided by the Dell ControlVault™ utility, which is embedded in Dell Latitude™ laptops.

ESTABLISHING A FOUNDATION WITH STORAGE-BASED SECURITY

The information-centric security strategy begins with a secure storage management network topology, leveraging the security features in Dell/EMC CX4 Series SAN arrays, Dell NX4 NAS devices, and EMC Celerra NS-120 NAS systems (see Figure 2). EMC storage is designed to meet Common Criteria for Information Technology Security Evaluation (ISO 15408) global security standards. Also, internal EMC policy mandates 80 distinct security-focused requirements for EMC hardware and software, including support for advanced security functions such as IP version 6 (IPv6) and IP Security (IPsec). These requirements ease integration into existing security infrastructures and provide a common security implementation across Dell and EMC storage systems that implement EMC security technologies (see Figure 3).

Security capabilities of Dell/EMC CX4 Series SAN arrays

Organizations using Dell/EMC CX4 Series SAN arrays can benefit from a variety of built-in security features. Standard authentication mechanisms are provided for both the EMC Navisphere® Manager software's graphical user interface and Navisphere Command-Line Interface (CLI) through encrypted, authenticated communications. Administrators must provide valid Navisphere Manager credentials, including username and password, to conduct storage system management operations. Authorized users can be authenticated using Lightweight Directory Access Protocol (LDAP) or the Microsoft® Active Directory® directory service, the Microsoft implementation of LDAP.

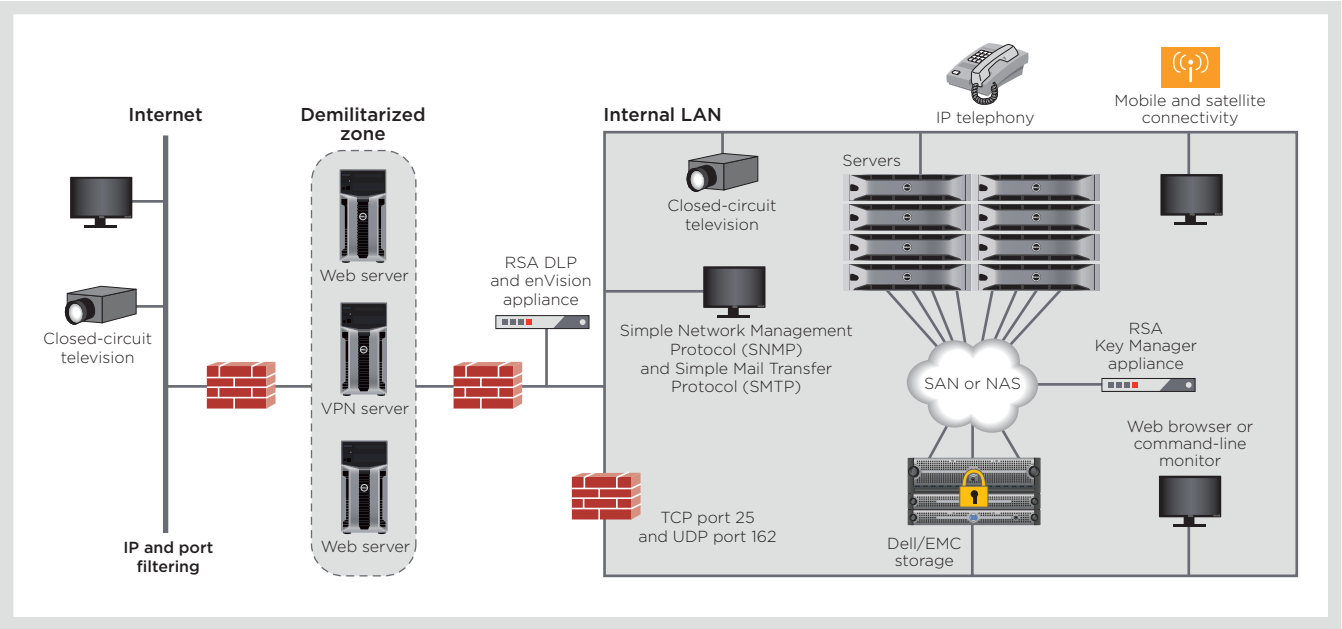

Figure 2. *Deploying a highly secure storage management network topology*

Navisphere Manager is designed to authorize user actions based on the role associated with the authenticated user. Each role has different access privileges for data and functions, providing account administrators with a tool to help simplify assigning access rights. Roles include administrator, security administrator, manager, monitoring, recovery, replication, and local replication only. Navisphere Manager also provides 256-bit symmetric data encryption using the RSA algorithm, which helps deliver the same level of cryptographic strength as is employed in e-commerce.

When a client connects to a server over the network, it is important that the client can verify the identity of the server—otherwise, any node on the network can potentially impersonate the server and extract information from the client, which is also known as a man-in-the-middle attack. Navisphere Manager uses Public Key Infrastructure (PKI) cryptography to help verify the identity of the Dell/EMC CX4 Series array when a client connects. Each Dell/EMC CX4 Series array processor contains a PKI certificate with a corresponding public key that is presented to the client.

Audit information for Dell/EMC CX4 Series arrays is contained within an event log for each storage processor. Navisphere Manager creates a detailed event log each time a user logs in, enters a request, or executes a command. Using this record, checks for suspicious activity can be performed periodically and the scope of activity can be determined, enabling the organization to take appropriate action.

Security features of Dell NX4 and EMC Celerra NS-120 NAS systems

EMC Celerra Manager provides security available in Dell NX4 and EMC Celerra NS-120 NAS systems, starting with industry-standard authentication. Protection for Microsoft Windows® files includes Microsoft NT LAN Manager (NTLM and NTLMv2), NTLM Security Support Provider (NTLMSSP), and Server Message Block (SMB) signing. Protection for Linux® and UNIX® OS files includes Kerberos, Network File System version 4 (NFSv4), and secure NFS protocols.

Like Navisphere Manager, Celerra Manager provides granular, role-based authorization. Administrative roles defined in Celerra Manager are system administrator, security administrator, and operator, and custom roles can also be defined. Flexible password management includes features such as minimum required length and complexity, and password expiration.

A separate management processor also helps limit access to data stored on Dell NX4 and EMC Celerra NS-120 systems. Administrators communicate only with the Control Station software available in these systems, and independent data movers then respond to Control Station management requests. Actions can be controlled by a defined set of management functions.

Multilevel privacy is built into Dell NX4 and EMC Celerra NS-120 systems. The proprietary Data Access in Real Time (DART) OS is designed to be immune to Windows and UNIX vulnerabilities. Celerra Manager is network protected with Secure HTTP (S-HTTP) for secure remote management; it checks for a valid session token and then tears down the token after a session is ended. Celerra CLI is network protected with Secure Shell (SSH) for secure remote management; it provides an encrypted session, and access is restricted to authorized clients or systems.

For auditing purposes, an event log is created each time a user logs in, enters

a request, or executes a command. Celerra Manager also supports virtual LANs (VLANs) to help secure data networks. VLANs provide a limited broadcast domain, helping reduce potential eavesdropping. Administrators can restrict traffic to specific ports and restrict access based on user ID.

BUILDING OUT THE SOLUTION WITH HOST AND APPLICATION SECURITY

To provide the next layer of protection in the information-centric model, Dell/EMC CX4 Series SAN arrays, Dell NX4 NAS devices, and EMC Celerra NS-120 NAS systems can leverage the capabilities of EMC PowerPath Encryption with RSA software, EMC RecoverPoint appliances, the RSA Key Manager (RKM) Suite, RSA enVision appliances, and the RSA Data Loss Prevention (DLP) Suite.

EMC PowerPath Encryption for data protection

EMC PowerPath Encryption provides host-based encryption for data at rest on disks, helping protect data against unauthorized access if a disk drive or array is removed from the system. It encrypts and decrypts data at the host, as the data moves to and from the array. The solution helps protect against unauthorized access or inadvertent loss of unprotected information through malicious attacks and spoofing of Fibre Channel hosts, and is designed to make information inaccessible in the event of physical theft of drives from the data center.

Data recovery and backup solutions are a key part of an effective security strategy to enable rapid recovery from downtime caused by security breaches such as zero-day attacks and hard drive theft. EMC RecoverPoint offers a unified solution to help protect and/or replicate data on storage systems by providing synchronous and asynchronous local and remote replication and continuous data protection for point-in-time recovery. Using PowerPath Encryption in conjunction with backup software, encrypted data can be copied synchronously or asynchronously to a disaster recovery site and remain protected regardless of where it resides.

RSA Key Manager to help simplify the key life cycle

RKM for the Datacenter provides a module that supports PowerPath Encryption. This module enables centralized enterprise key management for a consistent encryption methodology in mixed environments and helps simplify key management scalability as the organization grows.

	Secure access	Secure data	Secure audit
Dell/EMC CX4 Series SAN arrays	■ Secure remote support gateway ■ LDAP and Microsoft Active Directory authentication ■ Internet SCSI (iSCSI) Challenge Handshake Authentication Protocol (CHAP) ■ Logical unit (LUN) masking ■ Role-based accounts ■ Management domains ■ Secure administrator ■ IP address filtering	■ EMC Certified Data Erasure Service ■ Secure Sockets Layer (SSL) in EMC Navisphere Manager ■ Secure CLI ■ Secure remote support ■ Encryption with PowerPath	■ Secure audit log ■ RSA enVision integration
Dell NX4 NAS devices and EMC Celerra NS-120 NAS systems	■ Secure remote support gateway ■ LDAP and Microsoft Active Directory authentication ■ iSCSI CHAP ■ LUN masking ■ Kerberos ■ Secure management access ■ NAS access control lists (ACLs) and locking ■ Password management	■ EMC Certified Data Erasure Service ■ File retention write once, read many (WORM) ■ File extension filtering ■ Secure NFS ■ Antivirus integration	
EMC Symmetrix DMX™ arrays	■ Secure remote support gateway ■ LDAP and Microsoft Active Directory authentication ■ iSCSI CHAP ■ LUN masking ■ Role-based accounts ■ Kerberos (SymCLI) ■ System identifier (SID) lockdown ■ EMC Symmetrix® access control ■ Service credential	■ EMC Certified Data Erasure Service ■ Integrated data erasure (EMC Enginuity™ 5772 OS) ■ SSL in console and CLI ■ Encryption with EMC PowerPath	
EMC Centera® storage	■ Secure remote support gateway ■ Access profiles ■ Role-based access (management profiles) ■ Cluster locking	■ EMC Certified Data Erasure Service ■ Data shredding ■ WORM ■ File retention	
EMC ControlCenter® storage management software	■ LDAP and Microsoft Active Directory authentication ■ Role-based management ■ Fine-grained access control	■ SSL encryption	■ Comprehensive auditing ■ Secure audit log

Figure 3. *Implementing security features across Dell and EMC storage*

> **"The information-centric security strategy begins with a secure storage management network topology, leveraging the security features in Dell/EMC CX4 Series SAN arrays, Dell NX4 NAS devices, and EMC Celerra NS-120 NAS systems."**

The importance of controlling security keys becomes clear when disaster strikes. For example, if an organization's primary site burns down, the fire may destroy the DVD holding the organization's keys. When the IT team subsequently seeks to recover data at its disaster recovery site, the team would not be able to access data stored on encrypted backup tapes because the encryption keys are not available to decrypt the tapes. Another use case for enhanced key management includes simplifying support and maintenance of heterogeneous and legacy infrastructures. In legacy and new technologies, each application and OS may create its own keys, which can get lost because of staff turnover or aging systems.

The RKM appliance is designed to simplify the implementation, management, and availability of encryption keys throughout the life cycles of disparate applications, operating systems, and infrastructure. RKM provides functionality such as remote replication of keys to a disaster recovery site, application-level authentication and authorization, secure key storage, audit logging of key management operations, and reporting of key use across applications.

RSA enVision appliances for threat monitoring and forensic analysis

Dell/EMC CX4 Series arrays, Dell NX4 NAS devices, and EMC Celerra NS-120 NAS systems can provide log file audit trails through integration with RSA enVision to help simplify log management and forensic analysis and alerting. RSA enVision can collect log data from over 130 event sources from firewalls to databases, including syslog and custom or proprietary sources using standard transport protocols. The appliance compresses and encrypts log data so that it can be stored for later forensics analysis, while helping maintain data confidentiality and integrity.

RSA enVision is designed to analyze data in real time to check for anomalous behavior that requires an immediate response, and then optimizes logs for later reporting and forensic analysis. Built-in reports and alerts provide quick access to data that is easy to understand, and both standard and custom reports are available for compliance security including PCI DSS, SOX, and other compliance regulation modules.

RSA Data Loss Prevention for compliance and policy enforcement

The RSA DLP Suite is designed to give IT staff insight into the risk status and use trends of sensitive data across the enterprise based on policies, regardless of whether the data resides in a data center, on a network, or out at the endpoints. The suite helps safeguard data at rest by scanning across desktops, laptops, and file servers to locate and automatically monitor usage to provide protection of sensitive content. It also helps protect data in motion by tracking sensitive content movement across networks, creating an audit trail, and automatically blocking or remediating policy violations. The suite also monitors the use of sensitive data, exclusive of the application and destination, and can block prohibited actions.

RSA Data Loss Prevention and enVision for combined deployment

Combining RSA DLP and enVision appliances helps fine-tune security and compliance policies based on actual use and needs from within an organization. To detect and audit sensitive data, IT organizations can first configure policies and content detection modules in DLP, and run an infrastructure security scan to identify risks. As events are generated, DLP forwards events and alerts to the enVision appliance. RSA enVision then correlates this information with existing forensics data. Feedback from that analysis can be used to fine-tune DLP policies to help ensure sensitive data is stored and used appropriately.

COMPLETING THE STRATEGY WITH CLIENT-BASED SECURITY

Many organizations need a mobile workforce with access to enterprise networks and sensitive data, and must be certain that only users with the proper credentials are logging on to the network. Remote users often cannot remember passwords and other security credentials, and should not carry them around in written form, but they still need the credentials to access data and do their jobs. Organizations can implement the required security using Dell Latitude laptops with Dell ControlVault software based on RSA SecureID. RSA and Dell have worked together to provide users of Latitude laptops with embedded technology for two-factor authentication to virtual private networks (VPNs), Microsoft Office Outlook® Web Access, Citrix® applications, and other network resources.

This solution offers the hardware-level security with the cost-effectiveness and convenience of a software token;

administrators no longer need to replace lost tokens, and end users benefit from a consolidated device. ControlVault is designed to keep passwords, biometric templates, and security codes within firmware and locked away from malicious attacks.

TYING THE SOLUTION TOGETHER WITH SECURITY ASSESSMENT SERVICES

Customized security assessment services can bring together the elements of an information-centric security strategy by establishing a common framework. Dell ProConsult and EMC services are available to help organizations define security policies, discover and classify sources of sensitive information across the infrastructure, and implement appropriate controls. Auditing services are available to help ensure and document compliance with security policies. Organizations can also have Dell ProSupport proactively support Dell/EMC CX4 Series, Dell NX4, and EMC Celerra NS-120 storage systems—including monitoring, notification, diagnosis, and repair.

UNIFYING SECURITY MANAGEMENT ACROSS THE INFRASTRUCTURE

The adoption of Web 2.0 and the integration of hybrid networks, combined with the need to enable an IT infrastructure that supports rapid disaster response, makes an effective, enterprise-wide security strategy more important than ever. To help meet these needs, organizations are adopting an efficient, information-centric approach to data protection and security that authenticates, authorizes, and audits critical information assets and identities—helping to simplify the scalability of a secure architecture and streamline compliance.

Organizations looking to implement an information-centric security strategy may consider the multilayered protection provided by combined Dell, EMC, and RSA security capabilities designed to address today's increasingly complex security requirements. The ultimate goal of an information-centric security strategy is to help simplify deployment of security standards throughout the infrastructure stack—enabling efficient security management, forensic analysis, compliance, and data protection.

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 a SAS database programmer at Pacific Power and Light. Annette has a B.S. in Computer Science, Artificial Intelligence, from Colorado State University.

Mark Christenson is an EMC services partner manager for Dell/EMC solutions. He has 25 years of experience, including managing technical solution teams for enterprise infrastructure, security, and cloud services. As a tenure manager at EMC, and previously with EDS and Chase, he holds numerous industry certifications. Mark has a bachelor's degree from Ferris State University and a master's degree from Central Michigan University.

John McDonald is a security evangelist for RSA, where he is responsible for working with customers to design and deliver the EMC/RSA message and strategy. A Certified Information Systems Security Professional (CISSP), John has over 25 years of experience in the security industry, and has been actively involved with security at EMC and RSA for more than 9 years. Before joining EMC, he worked with several consulting companies performing security audits and security infrastructure design.

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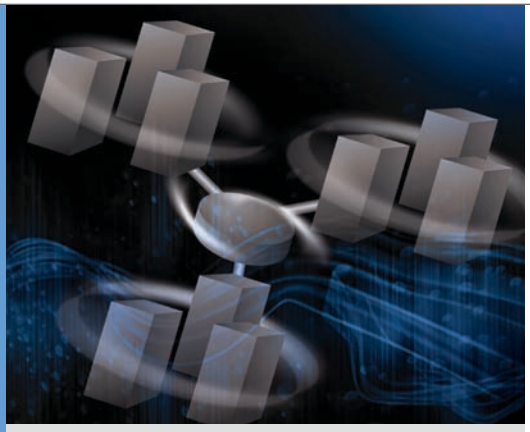


INTEL ETHERNET SERVER ADAPTERS MAXIMIZE THROUGHPUT PERFORMANCE FOR iSCSI CONNECTIVITY

By Sunil Ahluwalia
Gary Gumanow

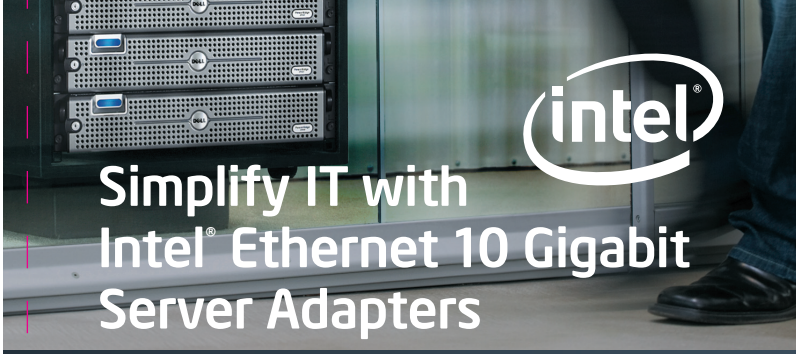
Internet SCSI (iSCSI) connectivity is a compelling option for enterprises building virtualized IT environments. By selecting Intel® Ethernet server adapters with Dell™ PowerEdge™ servers and Dell EqualLogic™ PS Series storage area networks, organizations can achieve enterprise-class application performance while benefiting from the cost- and labor-saving advantages of iSCSI connectivity.

The trend toward virtualizing the data center has led to increased demand for networked storage, which can play an essential role in provisioning, backing up, and migrating virtual machines (VMs). Increasingly, enterprise IT groups are deploying storage area networks (SANs) with Internet SCSI (iSCSI) connectivity to take advantage of existing cost-effective, easy-to-manage Ethernet networks. Given advances in servers, storage systems, server adapters, and operating systems, enterprise-ready iSCSI is compelling for IT organizations because it uses Ethernet, which is a standardized, widely deployed, and well-understood technology. Using Intel Ethernet server adapters to connect 11th-generation Dell PowerEdge servers and Dell EqualLogic PS Series iSCSI SANs enables IT groups to achieve the requisite performance for running enterprise workloads in a virtualized environment—while realizing the significant cost- and labor-saving benefits of iSCSI connectivity.

ACHIEVING ENTERPRISE PERFORMANCE WITH iSCSI CONNECTIVITY

Powerful servers are critical for achieving enterprise performance in a virtualized environment that uses iSCSI connectivity. The 11th-generation Dell PowerEdge server family, equipped with the Intel Xeon® processor 5500 series architecture, provides the processing performance, memory capacity, and I/O bandwidth needed to create a high-performance and scalable virtualized environment for business-critical applications. Beyond supplying the raw compute performance for hosting multiple VMs on each server, the Intel Xeon processors include Intel Virtualization Technology (Intel VT), which is designed to enhance host processing performance by providing hardware assistance for virtualization. In addition, advances in the memory architecture and support for Double Data Rate 3 (DDR3) memory help deliver significantly greater memory bandwidth compared with previous-generation Intel processors, enabling IT groups to host more applications on each physical server than in the past.

PowerEdge servers can also deliver the I/O bandwidth required to achieve outstanding performance in a virtualized environment. The Intel Xeon processor 5500 series architecture supports PCI Express (PCIe) 2.0 technology, which is designed to increase bandwidth for VM traffic by doubling the signaling bit rate of each I/O lane compared with previous-generation PCIe technology. This fast interface bus and the memory architecture enhancements of the latest Intel Xeon processors contribute to increased I/O scalability. The architecture enables



Simplify IT with Intel® Ethernet 10 Gigabit Server Adapters

The top 10 reasons to migrate to Intel® 10 Gigabit Server Adapters

1. **PERFORMANCE.** Maximize your server usage and get the most out of the latest multi-core processors — all without losing I/O performance.
2. **SIMPLICITY.** Reduce the complexity of your infrastructure by replacing multiple ports with a single 10 Gigabit port.
3. **COMPATIBILITY.** Enjoy full compatibility with iSCSI initiators on Windows*, Linux* and VMware ESX* operating systems.
4. **BANDWIDTH.** Give your I/O-hungry virtualized applications the additional bandwidth they need.
5. **EFFICIENCY.** Increase CPU utilization and help eliminate bottlenecks with the built-in virtualization performance of Virtual Machine Device Queues (VMDq) technology.
6. **EASE OF USE.** Easily connect your servers to your storage devices with iSCSI Remote Boot, which ships standard.
7. **COMFORT.** Enjoy peace of mind with industry-standard Ethernet.
8. **CHOICE.** Select among SFP+, CX4, 10GBase-T and SR Fiber interconnects.
9. **INTEROPERABILITY.** Take advantage of the proven interoperability of Intel® architecture in Dell PowerEdge* servers and network adapters.
10. **EXPERIENCE.** Benefit from Intel's unmatched Ethernet experience, including more than 25 years delivering network silicon and adapters.

The Intel – Dell Difference

Intel® Ethernet 10 Gigabit Server Adapters offer an unbeatable combination of performance and reliability from two of the world's most powerful companies.

- Proven performance on Dell PowerEdge* servers
- Combined 50+ years of experience
- World-class technical support
- Broad OS validation
- Multi-ports for scaling virtualized environments

Are You Ready to Simplify?

For more information about how Intel® 10 Gigabit Server Adapters can simplify your IT and increase your networking performance, visit www.IntelEthernet-Dell.com

Note: Not all Dell servers are compatible with all adapters. Please check with your Dell sales representative for more information.

Intel Xeon processor 5500 series–based servers with four 10 Gigabit Ethernet (10GbE) ports to scale up to nearly 50 Gbps of bidirectional network throughput—scalability that can be put to good use for supporting high-bandwidth applications in virtualized environments.[1]

Dell EqualLogic PS Series iSCSI SANs are well suited for virtualized environments running enterprise applications. With their redundant, hot-pluggable system architecture; RAID protection; and advanced monitoring capabilities, EqualLogic arrays deliver enterprise-class reliability and availability. To support a growing IT infrastructure, EqualLogic SANs can be scaled easily and seamlessly, without disrupting performance. Each EqualLogic array that administrators add helps increase not only storage capacity but also processing power, cache memory, and the number of available network connections. When administrators add arrays, the network load is spread across the new enclosures, enhancing throughput between servers and storage.

Moreover, EqualLogic SANs are designed for simplified management. They provide virtualized storage in which data volumes are provisioned automatically from a single scalable storage pool. To help maximize utilization of storage resources and streamline management, these SANs are designed to automatically load balance workloads from across all virtualized servers. As workloads change, storage resources are adjusted automatically, without requiring manual tuning. EqualLogic SANs also include a comprehensive suite of management tools, including advanced capabilities to support snapshots within a virtualized environment without additional software.

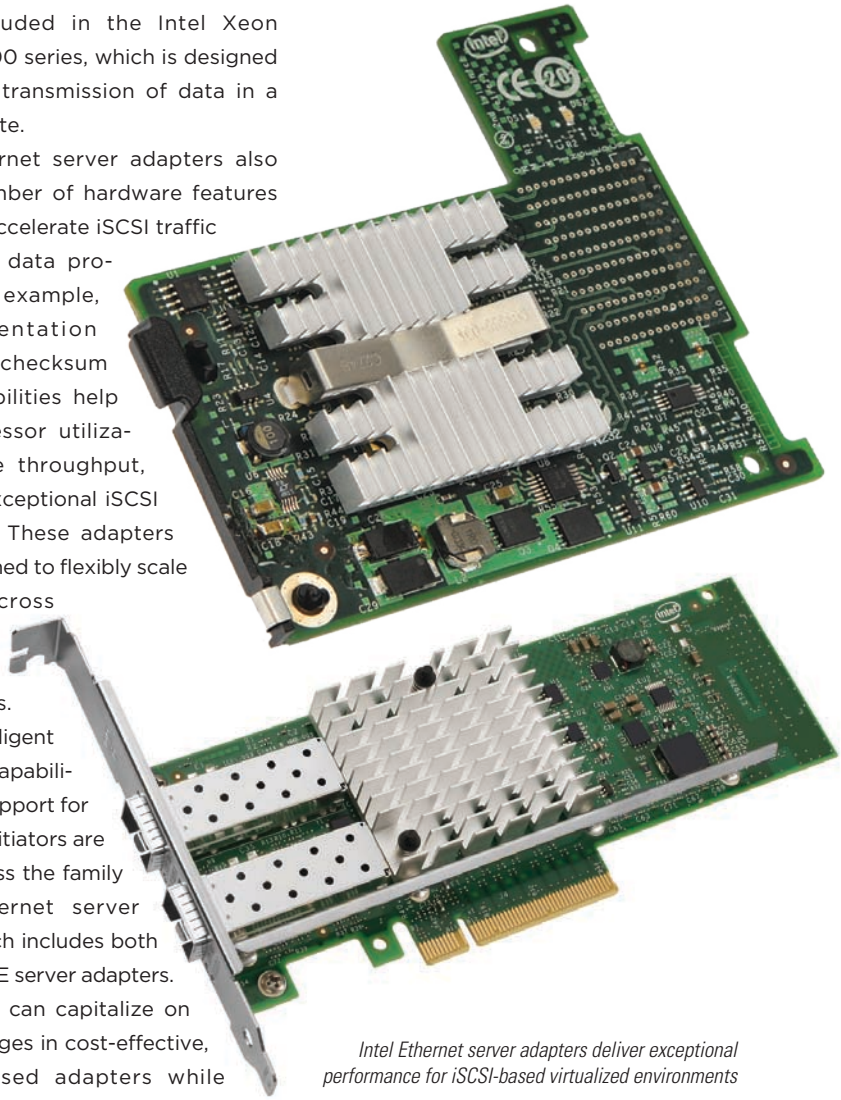
Using Intel Ethernet server adapters with native iSCSI initiators built into Microsoft® Windows®, Linux®, and VMware® ESX platforms can provide a simple, dependable, cost-effective way to connect PowerEdge servers to EqualLogic SANs, TCP/IP stacks, and network stacks. These native initiators are broadly tested using multiple generations of operating systems, storage systems, and OS tools to help ensure reliability and ease of use. Standardizing on Intel Ethernet server adapters for iSCSI allows administrators to use a single initiator, TCP/IP stack, and set of management tools and IT policies. In addition, native OS initiators such as the Microsoft iSCSI Software Initiator have consistently delivered advanced features such as multipathing and IP Security (IPsec). Moreover, native OS initiators support the CRC-32 digest instruction set included in the Intel Xeon processor 5500 series, which is designed to avoid the transmission of data in a vulnerable state.

Intel Ethernet server adapters also include a number of hardware features designed to accelerate iSCSI traffic and enhance data processing. For example, TCP segmentation offload and checksum offload capabilities help reduce processor utilization, increase throughput, and deliver exceptional iSCSI performance. These adapters are also designed to flexibly scale workloads across multi-core processor–based systems.

These intelligent acceleration capabilities and the support for native iSCSI initiators are available across the family of Intel Ethernet server adapters, which includes both GbE and 10GbE server adapters. Organizations can capitalize on these advantages in cost-effective, standards-based adapters while tailoring network connectivity to their specific needs.

OPTIMIZING iSCSI PERFORMANCE FOR VIRTUALIZED ENVIRONMENTS

Intel Ethernet server adapters also enhance performance in virtualized environments using iSCSI connectivity. Intel Virtual Machine Device Queues (Intel VMDq), a component of Intel Virtualization Technology for Connectivity (Intel VT-c) that is supported in Microsoft and VMware hypervisors, helps accelerate I/O performance by removing processing burdens from the hypervisor. In traditional



Intel Ethernet server adapters deliver exceptional performance for iSCSI-based virtualized environments

[1] Based on Intel testing performed in March 2009 using the bandwidth-intensive IxChariot network benchmark on an Intel preproduction system configured with two quad-core Intel Xeon X5570 processors at 2.93 GHz, 12 GB of DDR3 RAM at 1,066 MHz, an Intel 82599 10GbE controller, and an unmodified stock installation of Microsoft Windows Server 2008. Network throughput was measured on 64 KB I/O transfers between the test system and multiple network targets.

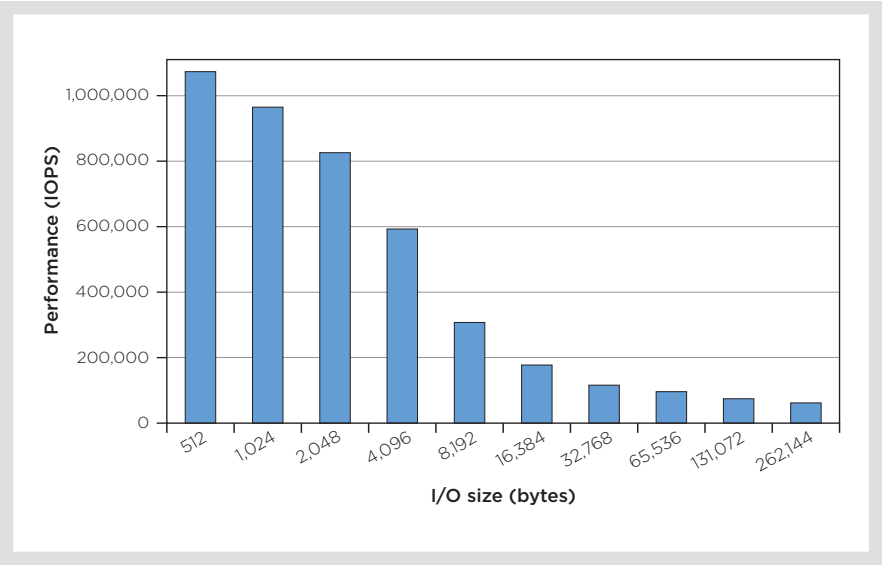


Figure 1. *Average iSCSI read/write performance using an Intel 10GbE controller and the native Microsoft Windows Server 2008 R2 initiator*

virtualized environments, I/O resources are shared among multiple VMs, and the hypervisor is responsible for sorting and routing packets from shared I/O to destination VMs—tasks that consume processor cycles and can diminish overall network I/O performance. With VMDq, the Ethernet controller sorts packets and then groups packets going to the same destination VM into the same queue. By removing processing burdens from the hypervisor, VMDq helps accelerate I/O traffic.

DELIVERING MEASURABLE RESULTS

By incorporating native iSCSI initiator support, intelligent acceleration capabilities, and virtualization optimizations, Intel Ethernet server adapters help organizations achieve high levels of iSCSI performance. In Intel testing, servers with the Intel Xeon processor 5500 series architecture and 10GbE server adapters achieved up to 1 million bidirectional, transmit-and-receive I/Os per second (IOPS) at block sizes of 512 bytes, without proprietary iSCSI offloads (see Figure 1).[2] This level of performance, attained using the native iSCSI initiator in the Microsoft Windows Server® 2008 R2 OS, is approximately twice that achieved using previous-generation solutions.[3] Although a number of factors can affect total IOPS in real-world implementations, the test results demonstrate the effectiveness of Intel Ethernet server adapters in helping deliver exceptional performance in environments using iSCSI connectivity. In a virtualized environment, this I/O throughput helps ensure strong performance for multiple applications running on each physical server.

MEETING THE NEED FOR COST-EFFECTIVE iSCSI PERFORMANCE

iSCSI has become a viable connectivity option for enterprise infrastructures deploying virtualized environments. Implementing iSCSI connectivity in a virtualized environment enables organizations to realize the benefits of virtualization in an efficient, cost-effective way. Intel Ethernet server adapters, available on a comprehensive range of Dell PowerEdge servers, provide a cost-effective, easy-to-manage solution that helps organizations achieve enterprise-class performance in virtualized environments with iSCSI connectivity.

Sunil Ahluwalia is a senior product line manager at Intel responsible for 10GbE products and marketing storage and security technologies for the data center. He has a bachelor's degree in Computer Science and Engineering from the Institute of Technology in Varanasi, India, and an M.B.A. from the Charles H. Lundquist College of Business at the University of Oregon.

Gary Gumanow is a senior product line manager at Dell responsible for iSCSI storage technologies and Dell EqualLogic PS Series storage arrays. He has degrees in Computer Science and Economics from the State University of New York at Buffalo and an M.B.A. from the Lubin School of Business at Pace University, and holds two patents for networking.

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www.intelethernet-dell.com

Dell PowerEdge servers:
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Dell EqualLogic PS Series:
DELL.COM/PSSeries
DELL.COM/EqualLogic

[2] Based on Intel testing performed in December 2009 using version 2006.07.27 of the Iometer benchmark on a virtualized server configured with two quad-core Intel Xeon W5580 processors at 3.2 GHz, 24 GB of DDR3 RAM, an Intel 82599 10GbE controller, and Microsoft Windows Server 2008 R2. The server hosted 10 VMs allocated with 2 GB of RAM each, and connected through a Cisco Nexus 5020 switch to an iSCSI software storage target at 10 Gbps. The Iometer benchmark was configured with 10 managers (1 per VM), 50 workers (5 per manager), and 50 LUNs (1 per worker), with 90 outstanding I/Os, I/O sizes ranging from 512 bytes to 1 MB, and a maximum transmission unit (MTU) of 1,500 bytes.

[3] Based on Intel testing performed in December 2009 using version 2004.07.30 of the Iometer benchmark on a server configured with two quad-core Intel Xeon X5365 processors at 3.0 GHz, 8 GB of RAM at 667 MHz, an Intel 82598 10GbE controller, and Microsoft Windows Server 2008. The server connected through a Cisco Catalyst 6509 switch to an iSCSI software storage target at 10 Gbps. The Iometer benchmark was configured with 1 manager, 12 workers, and 12 LUNs (1 per worker), with 4 outstanding I/Os, I/O sizes ranging from 512 bytes to 512 KB, and a maximum transmission unit (MTU) of 1,500 bytes.

QUANTUM STORNEXT: ACCELERATING THE ENTERPRISE WITH RAPID DATA ACCESS

As a deployment within Dell's own manufacturing centers shows, Quantum® StorNext® data management software enables a highly efficient, cost-effective approach to shared storage that can dramatically reduce server and storage requirements while providing high-speed access to critical data.

Rapid data access has long been a requirement in industries where large files must be accessed or shared by users without network delays. But the need for high-performance storage is increasingly familiar across a range of other industries as well, and scaling such systems can be expensive and complex. Too often, organizations must choose between cost-effective simplicity and a growing need for high performance.

Quantum StorNext data management software provides a third alternative that can provide both of those qualities—enabling an efficient, shared approach to storage that combines high-speed data access with cost-effective content retention. StorNext extends the scalability of Dell™ EqualLogic™ and PowerVault™ storage—and, in fact, Dell itself is implementing StorNext to support a critical, real-time process in the company's manufacturing operations. As the Dell deployment shows, StorNext can help to dramatically reduce server and storage requirements and increase performance even in highly sophisticated and demanding environments.

HIGH-PERFORMANCE DATA SHARING

StorNext helps to streamline shared storage environments and reduce data retention costs by creating a consolidated storage pool of images, media content, analytical data, and other key digital assets. It comprises two core components: StorNext File System, which provides single-namespace data-sharing functionality, and StorNext Storage Manager, which provides data-movement functionality.

StorNext File System enables multiple systems to access the shared storage pool in parallel, at high speeds—helping provide greater throughput and faster data sharing than typical network attached storage (NAS) architectures. The software is hardware agnostic and designed for heterogeneous OS environments, so the shared pool can be made up of varied disk types from different vendors and can work simultaneously with applications running on Microsoft® Windows®, Linux®, UNIX®, and Apple Mac OS X operating systems (see Figure 1).

StorNext also allows data sharing by hosts on both storage area networks (SANs) and local area networks (LANs). Where high data throughput is a critical factor, SAN-based servers running StorNext can provide direct, highly scalable access to files. When cost-efficiency or NAS-like functionality is a primary concern, LAN-based access using clustered gateway systems can provide higher resiliency and throughput compared with traditional network sharing methods. For both SAN- and LAN-based systems, shared storage is virtualized and presented as a native volume, which helps greatly simplify integration with nearly any application. Virtualization also allows for online volume expansion as well as swap-out of out-of-service arrays to help minimize downtime and simplify service.

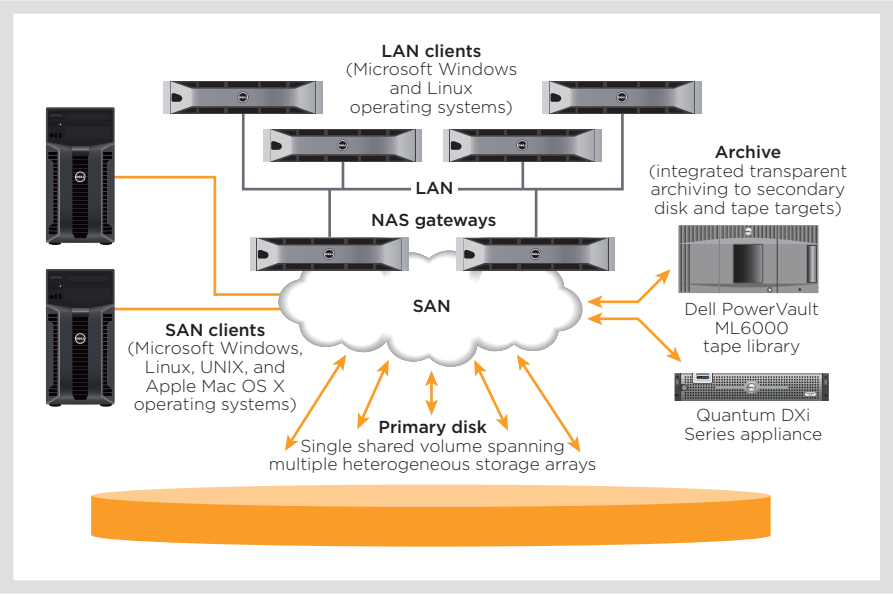

Figure 1. *Quantum StorNext is designed to support heterogeneous OS and storage environments*

StorNext Storage Manager is an integrated data-movement engine designed to transparently migrate files between multiple tiers of pooled storage to help reduce data-retention costs and provide data protection. This movement between tiers is handled automatically based on administrator-defined policies and file-access requirements. Tiers can include performance disk, value disk, tape libraries, and even NAS and massive array of idle disk (MAID) resources. Data location is virtualized so that files can easily be accessed for reuse—even if they reside on tape. StorNext is designed for extremely high levels of scalability to help meet both current and future needs.

A key feature of StorNext is its patented embedded deduplication functionality, which helps reduce the amount of storage capacity consumed by data. Unlike compression technologies that use a static pattern table to identify and eliminate redundancy within files, StorNext builds its pattern table on the fly using the organization's own data. This approach is designed to tune data-reduction activity to the organization's specific data set and increase the likelihood that very high levels of data reduction can be achieved—up to 94 percent, in the case of Dell's own deployment. StorNext deduplication is also cost-effective, making archiving on disk economically attractive for many organizations, even at sites that delete data after a short period of time.

STORNEXT IN ACTION

Dell began exploring Quantum StorNext technology as part of a broad effort focused on upgrading the infrastructure supporting its factories. In particular, the Dell IT group used StorNext to help significantly improve the process of loading applications and operating systems onto the hard drives of PCs going through the Dell build-to-order process. Traditionally, this process was performed by downloading software images from dedicated servers to the factory floor to meet specific requirements.

"It was a server-centric model, with the software images kept on the internal drives of individual stand-alone servers," says Mark Ruder, technology strategist in Dell's office of the CTO. To help ensure that images could be delivered to the factory floor in a timely manner, these servers housed a great deal of redundant data.

That approach was becoming increasingly difficult to manage as the business and the size of the images themselves grew. Standard images are about 4.5 GB in size, Ruder says, but custom ones can be as large as 110 GB. A single factory might have had 125 servers in place to support this process, with anywhere from 850 GB to 1.9 TB per server. "You just keep exceeding the capacity of those internal server drives, so you either buy a new system or larger drives," Ruder says. "It gets expensive, and it affects the space in the factory data center, which is limited."

As part of its upgrade effort, Dell moved to an architecture that used shared storage based on StorNext. Implementation began in the company's five design centers, where products and the processes to build them are developed. "These are really small microcosms of the factory, where they can test those processes," says Ruder. StorNext and the upgraded architecture clearly helped matters in the centers, he adds: "It allowed us to reduce our cost by changing the architecture and getting out of that server-centric storage model with internal storage and get to more of a shared cluster- and SAN-based approach."

For example, in Dell's Austin design center, the number of servers went from 18 to 11, and storage was reduced from 18 TB to just 8 TB. Across all the centers, server reductions ranged as high as 74 percent, with storage reductions ranging as high as 77 percent. Dell expects that this storage capacity will not need to be expanded for another two to three years. "The bottom line for the five design centers is that we saved more than US$1 million," says Jeffrey Lindner, systems engineer in the Dell IT group. Distribution has been simplified as well: "With StorNext, you have almost a single point of distribution per factory, instead of doing it individually for more than 100 servers."

A big part of the drop in storage requirements was due to the shared storage infrastructure, which meant that it was no longer necessary to have a given image copy housed on multiple servers—only one shared copy was needed. Lindner also points to the StorNext deduplication feature: "We now had a huge opportunity to reduce the size of the data itself, because

that deduplication feature helps ensure that we write only a unique copy of data to disk, instead of many copies." With the application and OS images, he says, "our deduplication reduction rate has been 74 percent to 94 percent. And that saved us money by lowering our storage footprint."

Dell is now rolling out StorNext and the upgraded infrastructure across its manufacturing plants globally—and seeing similar results. "We're going to go from 800 servers total to 230 to 250 Linux-based servers with StorNext," says Lindner. Historically, the amount of data stored in each plant system ranged from 68 TB to 266 TB. "With the shared file system and the deduplication feature, we're taking all the factories down to 10 TB or less," he says. At the same time, performance has significantly increased. Before the project, the factories had a 200 MB/sec architecture. Now, with the Novell® SUSE® Linux Enterprise Server–based architecture and StorNext, that performance has reached peaks of up to 1.6 GB/sec during internal Dell testing.

Dell is putting StorNext to work in other areas as well, including delivering software images to contract manufacturers and supporting driver downloads for end users. Looking ahead, Ruder says that the new approach provides flexibility for the future. "The heterogeneous nature of StorNext means that we're not locked into an OS technology," he says. "And if requirements change, we can scale this environment by utilizing StorNext and easily adding new servers."

EFFICIENT, COST-EFFECTIVE STORAGE

The recently released Quantum StorNext 4.0 version offers a number of enhancements, including a flexible, policy-based replication feature enabling comprehensive data protection, consolidation, and distribution solutions, among others; the use of Quantum deduplication technology in the primary storage tier to act as a near-line repository; and a distributed data mover that helps eliminate bottlenecks and provide rapid access when moving data to and from archives. StorNext continues to combine high-performance file sharing with transparent tiered storage to deliver simplicity and high performance—helping organizations accelerate their operations, share information rapidly and easily, increase productivity, and maintain enterprise assets in a cost-effective way.

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Quantum StorNext:
www.quantum.com/stornext

ROBUST, EFFICIENT DATA PROTECTION WITH SYMANTEC BACKUP EXEC 2010

By Charles Butler

The Symantec™ Backup Exec™ 2010 solution delivers comprehensive data protection from server to desktop. New features such as data deduplication and archiving help to reduce storage costs and increase backup performance, while support for the latest Microsoft® Windows® platforms and granular recovery from virtualized application servers help to simplify management for IT administrators.

As enterprises grow, a reliable backup and recovery system for production data becomes a key component of an effective IT infrastructure. And as virtualization becomes increasingly popular for critical applications such as Microsoft Exchange, these enterprises need software that can seamlessly protect both physical and virtualized servers.

The new Symantec Backup Exec 2010 solution provides integrated data protection for the latest Microsoft Windows environments, including the Windows 7 and Windows Server® 2008 R2 operating systems as well as Exchange Server 2010. Innovative technology designed for rapid recovery of Microsoft software such as the Exchange, SQL Server®, SharePoint®, and Active Directory® platforms as well as Microsoft Windows Server 2008 R2 Hyper-V™ and VMware® virtualized environments helps minimize downtime risks for critical applications. From a single-pass backup, administrators can rapidly restore entire applications or recover individual e-mail messages, files, and other data, and can even eliminate backup windows while supporting reliable point-in-time recovery through continuous data protection technology.

Backup Exec also provides centralized management to enable administrators to extend their backup infrastructures across distributed environments and remote offices, helping simplify ongoing operations as the environment expands. Support for managing systems running Windows and non-Windows operating systems—including Linux®, UNIX®, Novell® NetWare®, and Apple Mac OS X operating systems—through a single console, along with remote media server support for Linux-based servers, helps further simplify management of heterogeneous infrastructures.

In addition to these features, Backup Exec 2010 introduces a variety of enhancements over previous versions, including granular data recovery from virtualized applications in Microsoft Hyper-V and VMware virtual machines (VMs), flexible archiving options for Windows file systems and Exchange servers, and more. By taking advantage of these features to optimize their Windows data protection strategies, enterprise IT administrators can deploy robust, efficient backup and recovery while helping to streamline management and reduce costs.

COMPREHENSIVE PROTECTION FOR VIRTUALIZED ENVIRONMENTS

Backup Exec 2010 adds new functionality to the Microsoft Hyper-V and VMware agents introduced in Backup Exec 12.5. Both agents are licensed on a per-host basis without restrictions on the number of VMs that can run on each host, and support disk and

tape storage environments. Both agents also now extend Backup Exec Granular Recovery Technology (GRT) to virtualized applications such as Microsoft Exchange, SQL Server, and Active Directory, without requiring separate "brick-level" VM backups to recover individual items such as mailboxes, e-mail messages, private or public folders, calendar items, tasks, user accounts or attributes, SQL Server databases, and Active Directory objects (see Figure 1). Instead, these items can be recovered from image-level VM backups, helping to accelerate data recovery and reduce associated costs.

The Backup Exec 2010 Agent for Microsoft Hyper-V provides comprehensive protection for VMs running on a Windows Server 2008 R2 Hyper-V host while also helping protect existing physical server files and Windows applications. In addition, the agent adds support for the Clustered Shared Volumes (CSV) and live migration capabilities introduced in Windows Server 2008 R2.

The Backup Exec 2010 Agent for VMware Virtual Infrastructures delivers comprehensive disk-to-disk-to-tape data protection for growing VMware virtualized environments while helping protect existing physical server environments through a single flexible console. The agent enables Backup Exec 2010 to perform full, differential, or incremental VM backups to help maximize flexibility in virtualized environments. Integration with VMware vStorage application programming interfaces (APIs) helps maximize backup and recovery performance, while integration with VMware vCenter™ Server supports automatic VM discovery. Hyper-V and VMware VM backups can also be deduplicated using the Backup Exec Deduplication Option, helping to eliminate redundant data and reduce associated storage capacity requirements.

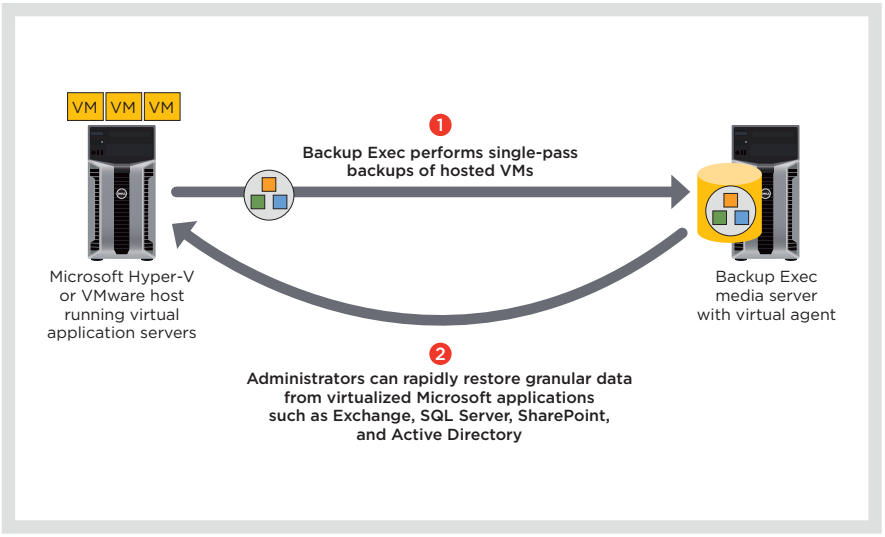

Figure 1. *Symantec Backup Exec 2010 agents enable rapid recovery of individual items from supported Microsoft applications*

FLEXIBLE ARCHIVING OPTIONS

Backup Exec 2010 incorporates support for two archiving options based on Symantec Enterprise Vault™ software—one for Microsoft Windows file systems and one for Microsoft Exchange (see Figure 2).

> **"The new Symantec Backup Exec 2010 solution provides integrated data protection for the latest Microsoft Windows environments, including the Windows 7 and Windows Server 2008 R2 operating systems as well as Exchange Server 2010."**

The Backup Exec 2010 File System Archiving Option provides unified backup and archiving for Windows file systems by archiving data from the backup copy rather than separately pulling data from the source. This option enables administrators to reduce redundant data from the file server source to help free up storage space. End users can easily retrieve individual archived documents and files through the Web browser–based Backup Exec Retrieve interface, while administrators can retrieve archived file data through the Backup Exec console.

The File System Archiving Option supports Microsoft Windows 2000 Server, Windows Server 2003, Windows Server 2008, and Windows Server 2008 R2 operating systems, and is licensed for each protected or archived server. It additionally requires the Backup Exec Agent for Windows Systems on each archived server.

The Backup Exec 2010 Exchange Mailbox Archiving Option provides similar unified backup and archiving functionality for Microsoft Exchange environments—archiving data from the backup copy rather than from the Exchange server, and enabling end users to retrieve individual archived e-mail messages through the Backup Exec

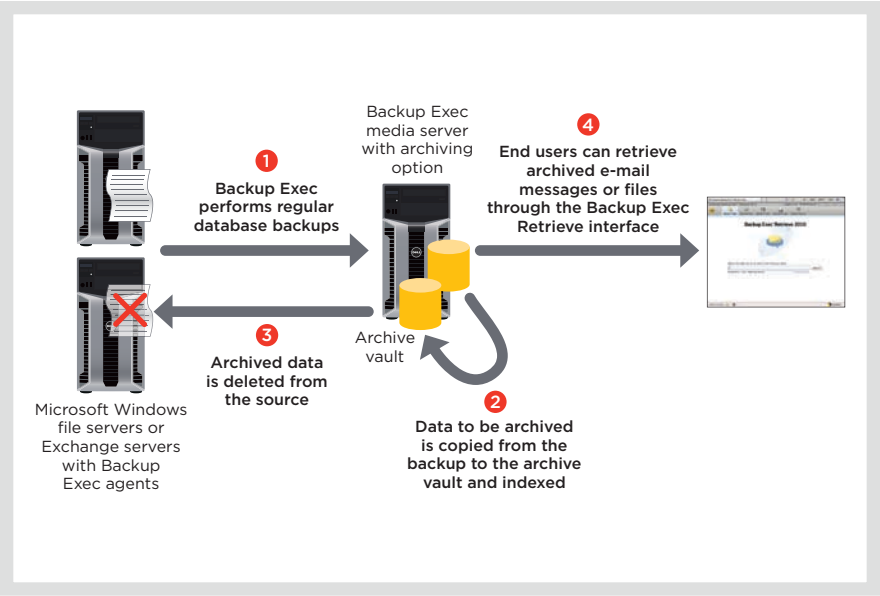

Figure 2. *Symantec Backup Exec 2010 options provide unified backup and archiving for Microsoft Windows file systems and Microsoft Exchange*

Retrieve interface while enabling administrators to retrieve archived data through the Backup Exec console. Administrators can easily index data and set retention periods to help them efficiently manage data life cycles.

The Exchange Mailbox Archiving Option supports Exchange Server 2003 and Exchange Server 2007, and is licensed in packs of 10 or 100 Exchange users. It additionally requires the Backup Exec Agent for Microsoft Exchange on each Exchange server.

ADDITIONAL FEATURES AND ENHANCEMENTS

Backup Exec 2010 introduces several other new features as well. It incorporates comprehensive protection for the Microsoft Windows 7 and Windows Server 2008 R2 operating systems, including the CSV feature for highly available Hyper-V deployments. Support for Microsoft .vhd files allows redirected file restore operations directly to .vhd files, with the .vhd files created as part of the restore process. In addition, Backup Exec 2010 supports the Volume Shadow Copy Service (VSS) writers introduced in Windows Server 2008 R2, providing a deep level of integration and protection for these environments.

Backup Exec 2010 also introduces the Virtual Tape Library (VTL) Unlimited Drive Option, which offers a simplified, cost-effective pricing method to license all VTL drives for use with a Backup Exec media server. The VTL Unlimited Drive Option allows administrators to integrate a VTL storage environment as a unique device that shows only tape functions that are valid for VTLs. Administrators can also modify VTL media to erase data that has reached its expiration date, helping reclaim storage space.

Finally, the Backup Exec 2010 Agent for Microsoft Exchange now supports Exchange Server 2010 and its database availability group (DAG) feature. Support for GRT helps eliminate the need to run mailbox or Messaging API (MAPI) backups, helping significantly reduce the number of backups and the time required to protect Exchange deployments. The enhanced Agent for Microsoft Exchange can granularly recover data from a single backup, helping eliminate the need for multiple backups. Fast, flexible technology helps protect critical Exchange 2000 Server, Exchange Server 2003, Exchange Server 2007, and Exchange Server 2010 data while the application is still online.

ROBUST, EFFICIENT BACKUP AND RECOVERY

The innovative architecture of Symantec Backup Exec 2010 is designed to fully incorporate Microsoft design standards, helping ensure compatibility with Microsoft Windows Server operating systems. Backup Exec 2010 support for Microsoft Hyper-V and VMware virtualized environments helps maximize flexibility by enabling granular data protection for both physical and virtualized application servers. In addition, Backup Exec 2010 can incorporate data reduction capabilities utilizing data deduplication, file system archiving, and Exchange mailbox archiving, providing a variety of ways to reduce storage requirements. Deploying these features in enterprise IT environments can help administrators protect critical data in an efficient, streamlined way while helping reduce storage and management costs.

Charles Butler is a technical director in the Data Protection Group at Symantec. He has a B.S. in Electrical and Computer Engineering from the University of Colorado at Boulder and an M.B.A. from St. Edward's University.

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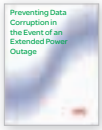
Energy savings: A patent-pending "green" mode achieves online efficiencies approaching 99 percent, reducing heat loss and utility costs.



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SYMANTEC VIRTUAL VAULT: SEAMLESS ARCHIVE INTEGRATION FOR END USERS

By Sean Roth

The end-user experience is a critical and frequently overlooked component of an effective archiving strategy. The virtual vault feature in the latest release of the Symantec™ Enterprise Vault™ 8.0 archiving solution enables seamless integration of archived e-mail messages and data into the Microsoft® Office Outlook® client to help streamline routine interactions and increase productivity.

For business users worldwide, the Microsoft Office Outlook client has long been the de facto portal through which the vast majority of daily communications and productivity files flow. An organization's implementation and management of an information archiving strategy (or lack thereof) is not generally at the top of end users' minds, especially when they find themselves in the midst of responding to a flurry of e-mail messages and uploading a set of spreadsheets to a Microsoft SharePoint® site, all while on an early-morning conference call. However, the situation can change drastically when these same users are thrust into dealing with archived message stubs, limited offline access to archived data, or manual management of Outlook .pst files—all of which can be time-consuming and hamper productivity.

Although most archiving solutions can help reduce costs and increase enterprise productivity, these scenarios illustrate how end users' interactions with archives can also be a critical component of an effective solution. The virtual vault feature of Symantec Enterprise Vault 8.0 with Service Pack 3 (SP3) was designed with these needs in mind—enabling simple, seamless integration of archived messages and data into Outlook to help streamline these interactions and increase end-user productivity.

SEAMLESS INTEGRATION WITH MICROSOFT OUTLOOK

Typically, archived messages or those stored in .pst files appear in Outlook as shortcuts, and message bodies are stubs that show abridged versions of messages along with prompts to download the full versions from the archive. This process can be a hindrance for end users, who must click to download the full version of a given message before they can edit, reply to, or forward it.

In addition to providing a comprehensive e-mail and content archiving solution for data center environments, Symantec Enterprise Vault 8.0 with SP3 incorporates a virtual vault feature to help avoid these barriers and provide a seamless experience for end users. This feature requires the client and server versions of Enterprise Vault 8.0 with SP3 or later, and supports both Outlook 2003 and Outlook 2007. Because a virtual vault is designed to look, feel, and behave like an Outlook .pst file, users familiar with .pst file management can interact with it as usual without interrupting their usual workflow. The archive appears as a separate node in the Outlook mailbox folder pane and mirrors the folder structure and nomenclature of the active in-box (see Figure 1). Users can easily drag and drop files to and from the archive across multiple sources—such as their

active mailboxes and local file folders—just as they normally would.

To support seamless interactions with archived messages, the virtual vault archived message folder provides full message-body preview and auto-preview capabilities. Users can even adjust their auto-preview settings in Outlook to present a specified number of characters in a message, and can work with that message as though it were part of their active e-mail folder.

This same seamless approach to displaying archived messages and data is also supported in the Outlook and Microsoft Windows® search capabilities: searches across Outlook, for example, can return a list comprising both live and archived messages. Considering how often a typical user would engage in these types of tasks during a given workday, it becomes clear that the streamlined search and manipulation functionality provided by Symantec virtual vaults can translate to significant time savings and increased productivity.

From the user perspective, the virtual vault feature offers high levels of transparency and ease of use. From the IT staff perspective, meanwhile, it has the advantage of being built right into the Enterprise Vault client, without requiring additional licensing costs. The virtual vault feature also helps avoid the need to use .pst files for archiving: because archiving transactions occur directly between the users and the archive itself, it can provide major advantages over the use of .pst files when factoring in the powerful Enterprise Vault deduplication capabilities and the tendency for .pst files to become corrupted as they approach the 2 GB size limit.

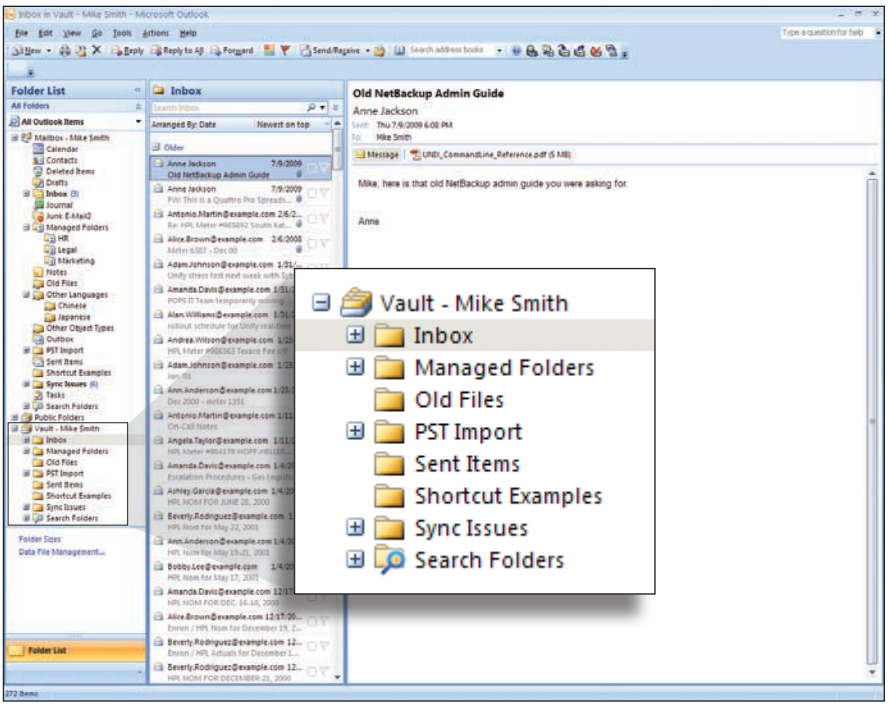

Figure 1. *The virtual vault feature of Symantec Enterprise Vault provides seamless access to archived messages and data in Microsoft Outlook*

STREAMLINED ARCHIVE INTERACTION FOR END USERS

For end users, interacting with archives in Microsoft Outlook using standard approaches can present a variety of barriers to efficient usage, including shortcuts, abridged messages, and otherwise altered messages. The virtual vault feature of Symantec Enterprise Vault 8.0 with SP3 is designed to enhance this experience of working with archived messages and data—providing a streamlined way to interact with archives and helping increase overall productivity.

Sean Roth is a product marketing manager with the Symantec Information Management Group, focusing on storage, archiving, and e-discovery technology partnerships for Enterprise Vault. He has a bachelor's degree in Computer Engineering from Concordia University in Montreal and an M.B.A. from Santa Clara University.

"From the user perspective, the virtual vault feature offers high levels of transparency and ease of use. From the IT staff perspective, it has the advantage of being built right into the Enterprise Vault client, without requiring additional licensing costs."

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MAXIMIZING DATA VALUE WITH IT ANALYTICS AND THE DELL MANAGEMENT CONSOLE

By Ryan Stolte
Feris Rifai

Bay Dynamics™ IT Analytics™ software incorporates multidimensional analysis, robust graphical trending, and key performance indicators to help IT organizations maximize the business value of data in the Dell™ Management Console Powered by Altiris™ from Symantec™.

As IT-related standards and automated collection tools become widespread, IT organizations have become increasingly data rich and knowledge poor—leaving IT managers to sift through rapidly growing amounts of data before they can extract meaningful information. Many decisions made in this context are based on highly formatted reports that can help answer a set of predetermined questions, but that may offer little in the way of interaction or analysis. By using IT Analytics software from Bay Dynamics, a certified Dell Management Console partner, IT organizations can make informed decisions based on actionable information about their IT infrastructures, helping them to simplify analysis and efficiently maximize the business value of their data.

BUSINESS INTELLIGENCE FOR THE DELL MANAGEMENT CONSOLE

The Dell Management Console Powered by Altiris from Symantec is a flexible framework built on the Symantec Management Platform that provides expandable capabilities by adding plug-in solutions. IT Analytics provides a starting point for administrators to explore data in the console's configuration management database (CMDB), allowing them to ask and answer their own questions on the fly. By providing timely access to data and visibility beyond preformatted reports, it can help IT organizations minimize the risk of making decisions too late or basing those decisions on educated guesses rather than real, actionable information.

The software offers a fluid mechanism that runs a sequence of administrator-defined queries—such as drilling down, drilling up, pivoting, and active filtering—to help them make the most of their information. As a result, they can explore the CMDB without advanced knowledge of databases or third-party reporting tools, and can ask and answer questions quickly, easily, and effectively. Rather than toiling over complex reports and basing decisions on assumptions or incomplete data, IT organizations can instead shift their focus to strategic thought leadership and positive change.

By leveraging the capabilities of IT Analytics, the Dell Management Console can help maximize the value of CMDB data and incorporate business intelligence tactics that include multidimensional analysis, robust graphical trending, and key performance indicators (KPIs). The combination helps IT staff to continually fine-tune their operations, observe compliance standards, and reduce costs.

UNIFIED VIEW OF IT DATA

IT Analytics provides a consistent, unified view of data derived from Dell Management Console plug-ins by transforming the raw data into fast, flexible online analytic processing (OLAP) cubes. These cubes form the core of IT Analytics, and are available in modular IT Analytics Packs for Dell client and server hardware, Altiris Client Management Suite™ and Server Management Suite™ software, Symantec Endpoint Protection, and more. IT Analytics can

present several views to help provide insight into the data, including the following:

- **Dashboards:** IT Analytics dashboards show related data at a glance and allow administrators and IT executives to drill down for detailed views (see Figure 1). They can then take action by using the integrated set of tasks available from Dell Management Console plug-ins.
- **Trend reports:** Visually informative trend reports help administrators understand the performance of critical infrastructure. Using IT Analytics can provide a comprehensive perspective on specific servers, correlating collected metrics with the resulting alerts and tasks to support closed-loop detection and remediation processes.
- **Pivot tables:** Drag-and-drop pivot tables are designed to mine data and identify KPIs, enabling administrators to view high-level summaries of data and then gain perspective on specific areas by dragging and dropping attributes.
- **Key performance indicators:** KPIs help administrators and IT executives measure critical success factors for the organization and quickly assess how these measures are changing over time. They capture a value and interpret the information in the context of a specific organization through visual indicators denoting the current status and the recent trend. For example, for the environment shown in Figure 2, the console shows that nearly 60 percent of the clients have completed a Symantec Endpoint Protection scan in the last 30 days. But this data alone is only part of the story. By viewing the KPI status and trend, administrators could see that this percentage indicates poor performance, but that the value has been improving—providing the type of valuable insight that can be critical to understanding and enhancing IT operations.

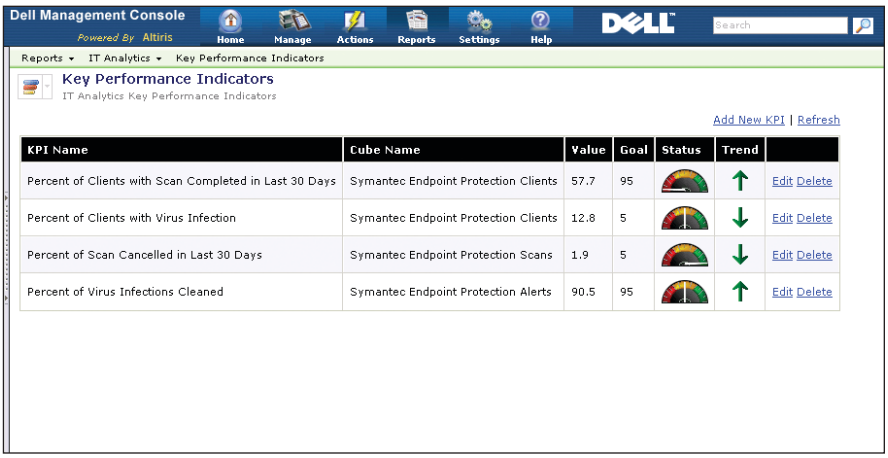

Figure 2. *IT Analytics key performance indicators in the Dell Management Console*

INTEGRATED PERSPECTIVE FOR INFORMED DECISIONS

With a huge and rapidly expanding amount of data at their disposal, administrators need tools that can help them quickly understand what that data means for their infrastructure and their organization. IT Analytics software from Bay Dynamics offers a powerful, flexible way to explore data in the Dell Management Console, enabling IT organizations to move from being reactive to proactively measuring, managing, and continually improving their operations and their bottom line.

Ryan Stolte is the CTO and cofounder of Bay Dynamics.

Feris Rifai is the CEO and cofounder of Bay Dynamics.

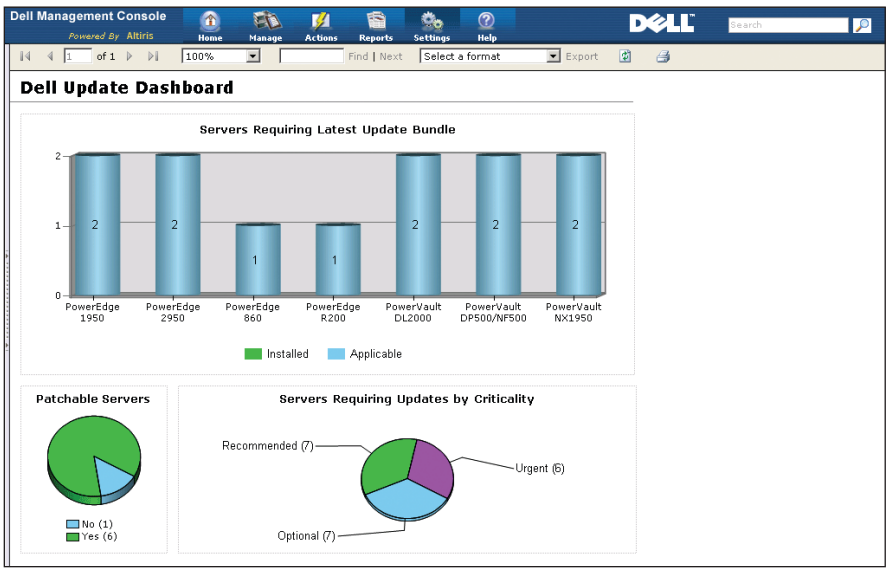

Figure 1. *IT Analytics dashboard summarizing servers requiring updates in the Dell Management Console*

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USING DELL REPOSITORY MANAGER TO SIMPLIFY UPDATES FOR DELL POWEREDGE SERVERS

By Bhuvaneshwari Robin
Jamal Blackwell
James Watt

By providing a simplified, centralized way to identify, organize, and prepare updates for Dell™ PowerEdge™ servers, the Dell Repository Manager tool helps significantly streamline change management and lower ongoing maintenance costs.

In enterprise IT environments, periodic hardware updates are generally necessary for effective systems management and operation. The IT administrators are responsible for tracking available updates for their systems, and then determining which to deploy and when to do so. In making these decisions, they must identify the relevant updates, evaluate the severity of the issues those updates address or the value of the new features they provide, and schedule the updates they choose to deploy.

Often, the information needed to make these complex decisions is not available from one source. Administrators must devise their own system for tracking and collating the necessary information and for retaining these notes for the next time they consider upgrading their servers. For these reasons, the change management process of defining and deploying baseline configurations can be a tedious and error-prone task.

Updates for Dell PowerEdge servers are typically delivered in Dell Update Packages (DUPs), which include self-contained installation packages for server BIOSs, firmware, drivers, and systems management applications and agents. Although over a thousand DUPs are available on the Dell FTP site, however, only a small subset of these files are likely to be relevant to a specific IT environment.

For environments with Dell servers, administrators can take advantage of the Dell Repository Manager tool to search through the DUPs, create a custom update repository, and then prepare these updates for deployment through existing deployment mechanisms. By doing so, they can dramatically cut down on the time needed to identify, organize, and prepare updates during their server maintenance cycles—helping to simplify and streamline these tasks and lower ongoing administrative costs.

COMPREHENSIVE DELL UPDATE MANAGEMENT

Dell Repository Manager consists of a stand-alone graphical interface that administrators can use during the planning phase of their change management processes to help quickly acquire and organize DUPs available for their Dell PowerEdge servers. Administrators can use the tool to define custom baseline configurations for use across the Dell servers in the environment, in addition to downloading and managing updates within the IT infrastructure. They can then organize these DUPs into bundles of related updates (see Figure 1).

For each repository, Dell Repository Manager creates an XML file called a catalog, which specifies the contents of that repository. Administrators can

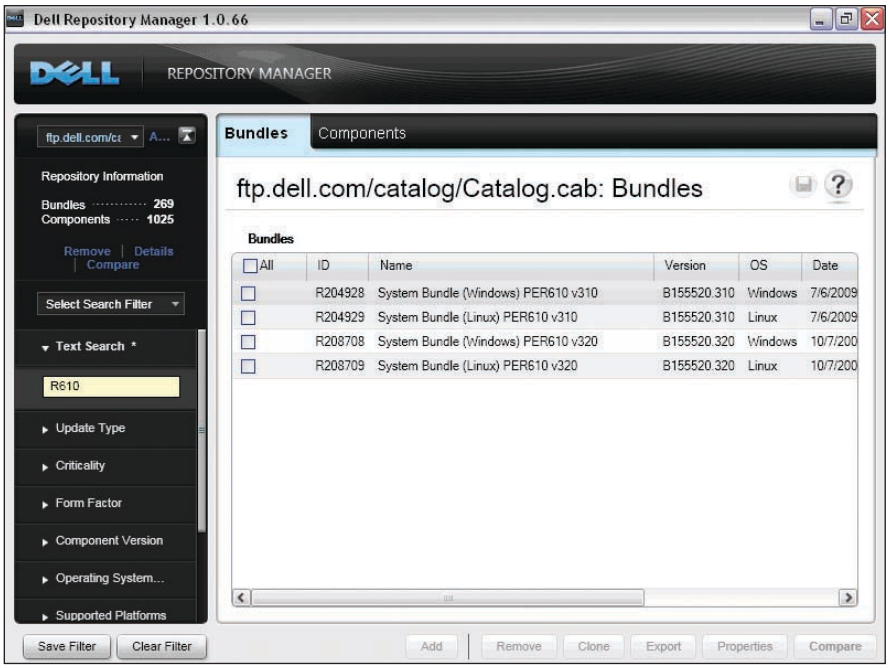

Figure 1. *Viewing bundles for a specific system in Dell Repository Manager*

compare two catalogs against each other to help easily identify and reconcile differences between specific repositories, such as a custom local repository and Dell's latest DUP repository. The tool also supports multiple export formats to help ensure compatibility with existing infrastructures (see Figure 2).

Key Dell Repository Manager features include local baseline repositories, custom baseline configurations, repository comparison reports, preboot Linux® ISO images, raw Microsoft® Windows® driver packs, lightweight deployment scripts, and customized Dell OpenManage™ Server Update Utilities (SUUs).

Local baseline repositories. Dell Repository Manager can be configured to create a local repository, which administrators can then synchronize with the catalog available at the Dell FTP site to receive the most recent updates. This local repository can in turn work as a collection of baselines for updating Dell servers within the network.

Custom baseline configurations. It is common practice to identify a collection of drivers, firmware, and other essential software for server configuration before provisioning a system. Dell Repository Manager supports this need through bundles—administrator-specified collections of deployable update packages. After administrators have identified the updates for a specific configured server on the network, they can save this baseline collection in the catalog as a bundle. When operating systems and platforms are associated with a bundle, Dell Repository Manager helps ensure that administrators do not inadvertently include updates that are not compatible with the specified configuration, which makes keeping a repository up-to-date easier and less error-prone than it would be otherwise. Effective use of these custom baseline configurations helps significantly simplify periodic system updates in keeping with internal enterprise schedules.

Repository comparison reports. After administrators have created a custom repository, they may want to update its contents to include updates released by Dell. Dell Repository Manager can automate this process by producing an HTML document specifying the differences between the custom repository and the official Dell repository. The tool can also selectively modify the custom repository to include new updates that administrators want to deploy.

Preboot Linux ISO images. When preparing for OS installation, administrators typically customize the hardware

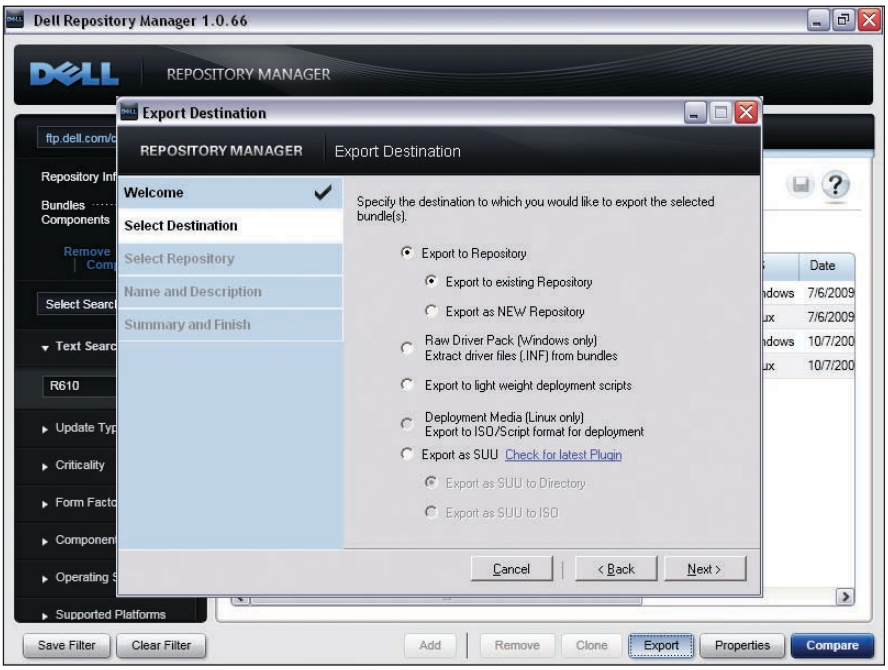

Figure 2. *Exporting selected update bundles in Dell Repository Manager*

> **"Dell Repository Manager consists of a stand-alone graphical interface that administrators can use during the planning phase of their change management processes to help quickly acquire and organize DUPs available for their Dell PowerEdge servers."**

configuration during server provisioning based on specific organizational requirements. During server provisioning, ensuring that hardware components are updated is a critical step, because some applications may require specific BIOS, firmware, driver, or application versions during installation. By updating the server components during this pre-OS phase, administrators can avoid spending time and effort later on checking for and applying server component updates.

Dell Repository Manager can create a CD image of a bootable Linux ISO image containing the Dell OpenManage Deployment Toolkit (DTK) and the system updates specified in the custom catalog. The DTK then provides an optimum, OS-independent runtime environment for DUP extraction. After the ISO image is booted on the targeted systems, the DTK runs a custom startup script that allows administrators to apply the system updates relevant to those servers.

Raw Microsoft Windows driver packs. Dell Repository Manager consolidates driver updates from administrator-defined bundles for specific Microsoft Windows–based servers by creating a customized driver pack. This driver pack consists of the Windows driver updates from each bundle and a batch script to install them on the servers. Administrators can use the batch script with other systems management tools during OS installation to update the drivers to the desired version.

Lightweight deployment scripts. Dell Repository Manager can generate lightweight deployment scripts to update hardware components in both Windows and Linux post-OS deployment environments. For a given bundle in the repository, administrators can create a simplified deployment solution to apply those updates to appropriate servers after the OS has booted.

Customized Dell OpenManage SUUs. The Dell OpenManage SUU contains the latest DUPs to use when applying updates to servers in Windows or Linux post-OS environments. Administrators can use the SUU to view available updates for a given system and then selectively apply those updates as needed. Dell Repository Manager can not only create a SUU release of a given repository, but can also edit the repository of DUPs that accompanies a SUU release to contain only the updates that apply to relevant servers, facilitating the generation of customized SUUs of greatly reduced storage size.

STREAMLINED ADMINISTRATION FOR DELL SERVERS

By providing a central location for planning DUP deployment, Dell Repository Manager is designed to significantly simplify the process of managing updates for Dell PowerEdge servers. Administrators can use this tool to easily search the Dell catalog of update files, store the relevant updates, and create and modify collections of updates for later deployment. The variety of supported export formats helps increase flexibility whether administrators deploy updates through an existing deployment infrastructure or directly to a server using lightweight deployment scripts. By helping reduce the time administrators must spend identifying, organizing, and preparing appropriate configurations for Dell servers, Dell Repository Manager can free up their time for other important tasks while helping reduce total cost of ownership.

Bhuvaneshwari Robin is a software engineer in the Dell ISV Partner Program Group focused on implementing advanced solutions for enterprise systems management tools. She has a B.E. in Electronics and Telecommunications Engineering from the University of Mumbai.

Jamal Blackwell is a software engineer in the Dell ISV Partner Program Group. He has 10 years of experience in software development, and joined Dell to design and implement reusable solutions to recurring systems management software integration tasks. Jamal has a B.S. in Computer Science from the Massachusetts Institute of Technology.

James Watt is a software engineer in the Dell ISV Partner Program Group specializing in the automation of internal DUP release processes for enterprise systems management tools. He has a B.S. in Computer Science from the University of Texas at Austin.

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UNIFIED MONITORING AND PROACTIVE MANAGEMENT OF DELL HARDWARE WITH MICROSOFT SYSTEM CENTER

By Viswanathan Balakrishnan
Saravan Kumar
Mahendran P.
Vignesh Pandian

Dell™ Management Packs developed for Microsoft® System Center enable monitoring and management of supported Dell devices and systems using Microsoft System Center Operations Manager and System Center Essentials—helping to automate routine tasks and create an efficient, unified framework for simplified systems management.

Monitoring and managing hardware devices can be complex, time-consuming, and costly in data center environments. The Dell OpenManage™ Integration Suite for Microsoft System Center is designed to simplify and streamline time-consuming IT management using System Center Operations Manager (SCOM), System Center Essentials (SCE), and System Center Configuration Manager. The SCOM management solution is well suited for enterprise-class environments, and is capable of providing a comprehensive, dynamic view of the health of thousands of servers, business client systems, network devices, and software applications through a single console. SCE, designed specifically for small and midsize IT environments with up to 30 servers and 500 PCs, provides monitoring and alert resolution for servers, business clients, network devices, and software applications; software distribution; hardware management; and hardware and software inventory. It also incorporates update management capabilities that enable administrators to view, download, and deploy software updates for managed systems.

The Dell OpenManage Integration Suite includes Dell Management Packs (MPs) and related utilities that provide monitoring and proactive management capabilities for supported Dell servers, blades, Dell Remote Access Controllers (DRACs), Integrated DRACs (iDRACs), Chassis Management Controllers (CMCs), storage arrays, business clients, and networked printers in environments using SCOM 2007 with Service Pack 1 (SP1), SCOM 2007 R2, or SCE 2007 with SP1; in this article, *Operations Manager* is used to refer generically to both SCOM and SCE. These MPs—available as software downloads from the Dell Web site at no additional cost—bring multiple advantages to IT environments:

- **Seamless management of heterogeneous systems:** Organizations already using Operations Manager can leverage their existing investment while adding seamless management of Dell hardware.
- **Centralized administration:** Administrators can manage a variety of Dell devices through a single unified console, helping to simplify ongoing management tasks.
- **Flexible deployment:** Administrators can choose to deploy only the MPs relevant to managing specific Dell hardware in their IT environment.
- **Proactive management:** Critical, warning, and informational alerts from Dell MPs enable administrators to respond to impending failures and help prevent those failures before they actually occur.

By taking advantage of these Dell integration tools, IT administrators can create an efficient, unified framework for simplified systems management.

INTEGRATION ARCHITECTURE FOR MICROSOFT SYSTEM CENTER

Figure 1 shows a best-practices configuration for managing a variety of Dell devices in a large-scale data center environment. This example infrastructure comprises a root management server, multiple management servers, a database server, and a data warehouse server; multiple management servers are required for managing specific Dell devices in this type of large environment. The communication channels can include Dell instrumentation components such as Common Information Model (CIM) providers, in-band agents, the out-of-band Intelligent Platform Management Interface (IPMI), command-line interfaces (CLIs), and Dell system event logs (SELs).

Figure 2 summarizes the Dell MPs and utilities that can integrate with Operations Manager. In addition to the listed management requirements, administrators should ensure that they have deployed supported instrumentation and firmware

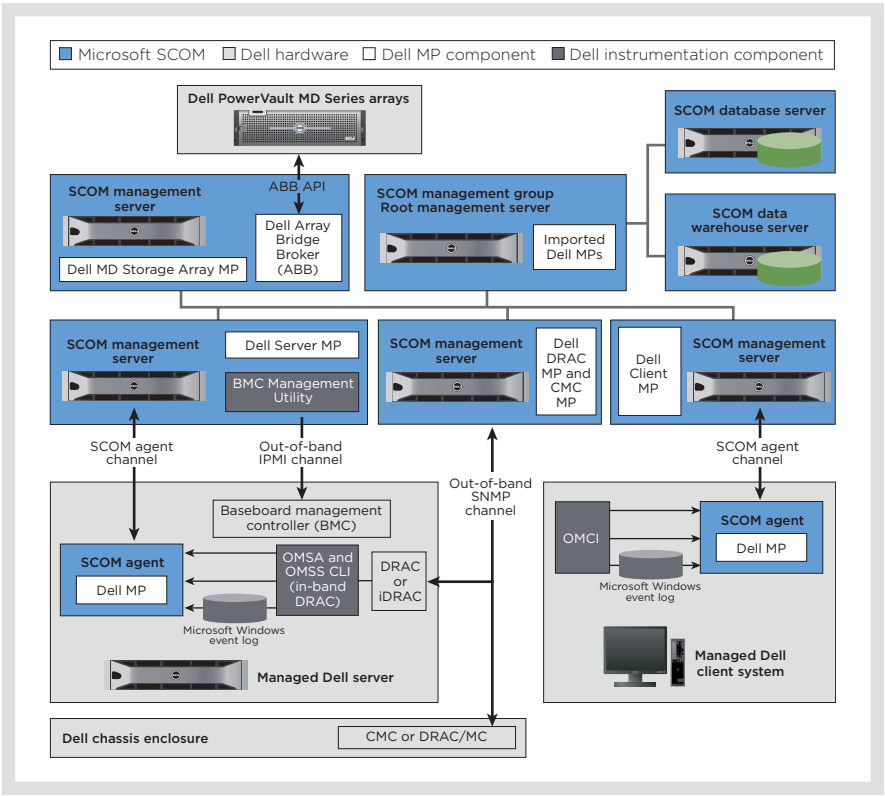

Figure 1. *Best-practices architecture for managing Dell devices using Microsoft System Center Operations Manager*

	Devices and monitoring	Management requirements	Typical usage
Dell Server Management Pack Suite			
Scalable Server MP	In-band management for PowerEdge servers (including both monolithic servers and modular blade servers) and PowerVault servers running supported Microsoft Windows Server® operating systems	OMSA, including Dell OpenManage Storage Services (OMSS)	Large and very large enterprise environments
Detailed Server MP	In-band management for PowerEdge servers (including both monolithic servers and modular blade servers) and PowerVault servers running supported Microsoft Windows Server operating systems, including storage controller components	OMSA, including OMSS	Small and medium business and enterprise environments
DRAC MP	Out-of-band management for DRAC 4, DRAC 5, modular iDRAC 6 (Enterprise), and monolithic iDRAC 6 (Enterprise and Express) controllers in PowerEdge servers (including both monolithic servers and modular blade servers) and PowerVault servers	Embedded SNMP and supported firmware	Environments of all sizes
CMC MP	Out-of-band management for CMC and DRAC/MC controllers in PowerEdge modular blade enclosures	Embedded SNMP and supported firmware	Enterprise and large enterprise environments
Information-Alerts-On Utility	Dell OpenManage events from Microsoft Windows® event logs for PowerEdge servers (including both monolithic servers and modular blade servers) and PowerVault servers	OMSA, including OMSS	Environments of all sizes
Dell Client Management Pack			
Client MP	In-band management for supported Dell OptiPlex, Dell Latitude, and Dell Precision business client computers running supported Microsoft Windows operating systems (including discovery and classification support for Dell Vostro desktops and laptops)	OMCI	Environments of all sizes
Dell Printer Management Pack			
Printer MP	Out-of-band management for Dell networked printers	Embedded SNMP	Environments of all sizes
Dell PowerVault MD Storage Arrays Management Pack Suite			
MD Storage Array MP	In-band and out-of-band management for PowerVault MD3000 and PowerVault MD3000i storage arrays	Embedded SNMP and supported firmware	Environments of all sizes
Discovery Utility	In-band and out-of-band discovery for PowerVault MD3000 and PowerVault MD3000i storage arrays	Embedded SNMP and supported firmware	Environments of all sizes

Figure 2. *Dell Management Pack components in the Dell OpenManage Integration Suite for Microsoft System Center*

versions for monitoring and managing specific devices.

Dell Server Management Pack Suite

The Dell Server Management Pack Suite comprises the Dell Hardware Library Grouping Utility, the Information-Alerts-On Utility, and four MPs:

- **Scalable Server MP:** This MP models system components at a high level, and is designed primarily for use in large environments with more than 300 managed systems. For instance-level instrumentation details for a specific system, administrators using the Scalable Server MP can launch the Dell OpenManage Server Administrator (OMSA) console.
- **Detailed Server MP:** This MP is an extension of the Scalable Server MP, and models additional instance-level information for BIOS, processor, memory, storage, and sensor components.
- **DRAC MP and CMC MP:** The DRAC MP supports a variety of DRAC and iDRAC controllers, classified into subgroups for specific models under the Dell Remote Access group; the CMC MP supports CMC and DRAC/Modular Chassis (DRAC/MC) controllers, classified into the Dell Modular Chassis group. Both MPs provide additional alert views for Simple Network Management Protocol (SNMP) traps and Platform Event Traps (PETs) along with their corresponding knowledge base information.

Dell MPs categorize agent-installed Dell systems and other devices into Dell Hardware or Dell Windows Server groups (for Dell PowerEdge™ and PowerVault™ systems), and further groups them into Dell Modular, Dell Monolithic, or (when the instrumentation is either not present or unresponsive) Dell Unknown systems. Status monitoring for these systems includes Dell-specific and pre-failure alerts. Administrators can also launch Dell instrumentation consoles from Operations Manager to perform granular problem-solving analysis. Dell-specific views in the Operations Manager console include alert views embedded with related knowledge base information, diagram views that classify devices into logical groups (see Figure 3), state views based on event and status poll information, and a performance and power monitoring view that provides power and temperature data.

Dell Client Management Pack

The Dell Client MP discovers and classifies Dell business client computers using Dell OpenManage Client Instrumentation (OMCI) into Dell Hardware, Dell Windows Client (for Dell OptiPlex™, Dell Latitude™, and Dell Precision™ systems), or Dell Unmanaged (for systems where the instrumentation is either not present or unresponsive) groups, providing advanced monitoring capabilities for Dell business client systems through Operations Manager.[1] This MP models the components on a high level in addition to providing component details such as memory unit instances. Administrators can use it to reboot or power down managed clients and generate reports for specified systems.

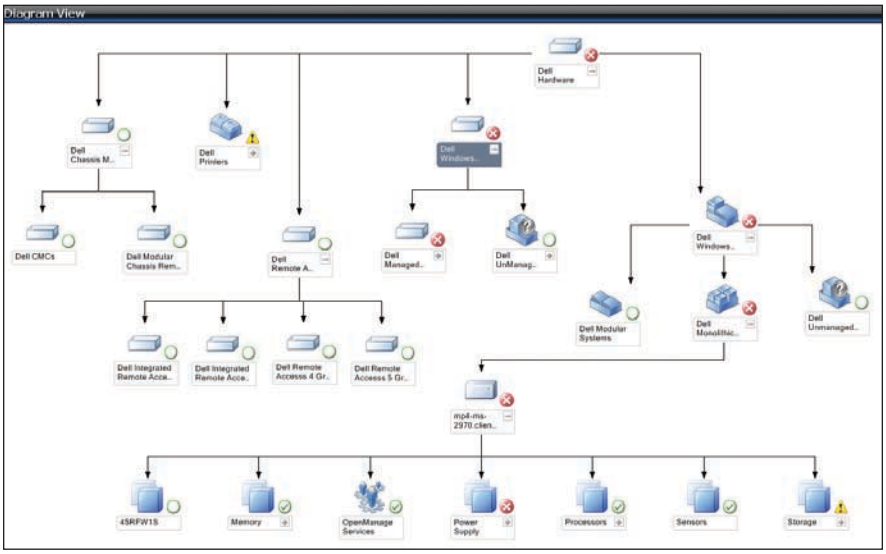

Figure 3. *Complete Diagram View for Dell devices in Microsoft System Center Operations Manager 2007 R2*

Dell Printer Management Pack

The Dell Printer MP combined with SNMP-based Operations Manager network device discovery classifies Dell printers into specific views and supports inventory, health monitoring, and SNMP traps as well as launching the printer console.

Dell PowerVault MD Storage Arrays Management Pack Suite

The Dell PowerVault MD Storage Arrays Management Pack Suite, comprising the Dell MD Storage Array MP and the Dell Discovery Utility, provides basic discovery, monitoring, and alert management for PowerVault MD3000 and PowerVault MD3000i storage arrays as well as PowerVault MD1000 arrays daisy-chained to one of those two array models. It supports IP version 4 (IPv4) and IPv6 and both in-band and out-of-band management.

The MP diagram view includes specific representative icons for individual components. The alert view provides alert-specific recovery information for individual alerts along with information on causes, resolutions, important notes, recovery information, and so on, which administrators can use as a point of reference when troubleshooting storage arrays. The Dell Discovery Utility is designed to automatically discover supported storage arrays with both IPv4 and IPv6 addresses over a network and then update the IP listing file used by Operations Manager.

[1] The Dell Client MP also supports basic discovery and classification of Dell Vostro™ desktops and laptops, with no additional monitoring or management capabilities.

ENHANCED ENERGY MONITORING

Combining the OMSA instrumentation's energy monitoring capabilities with SCOM through the Scalable Server MP or Detailed Server MP can provide significant benefits in data center environments. IT administrators can leverage the alerts from Dell hardware that has exceeded defined performance and power consumption thresholds to derive load-balancing decisions. Threshold monitoring for the various counters are disabled by default in these MPs, and can be enabled for a defined set of values depending on specific needs. Administrators can take advantage of historical energy consumption data presented through the intuitive Operations Manager console to help them make future purchasing and deployment decisions. Administrators can also view key power monitoring data—such as ambient temperature, amperage, energy consumption, power amperage, system peak power, and power consumption in watts and BTU/hour—corresponding to a monitored server.

SCALABILITY IN LARGE ENTERPRISE ENVIRONMENTS

Even with careful planning, systems management frameworks can cause traffic bottlenecks in data center environments. These bottlenecks can further lead to processor, memory, I/O, and other types of bottlenecks.

Dell MPs have been developed for monitoring and managing a large number of servers and clients and are designed with the scalability and management patterns of large environments in mind. For example, the MPs have been optimized to ignore less critical status updates from monitored hardware (including informational alerts) to enhance scalability, while still offering administrators the flexibility to override these optimizations if the immediate priority is more detailed management. Figure 4 shows an example data center environment scaled to monitor more than a thousand Dell PowerEdge servers in SCOM 2007 R2.

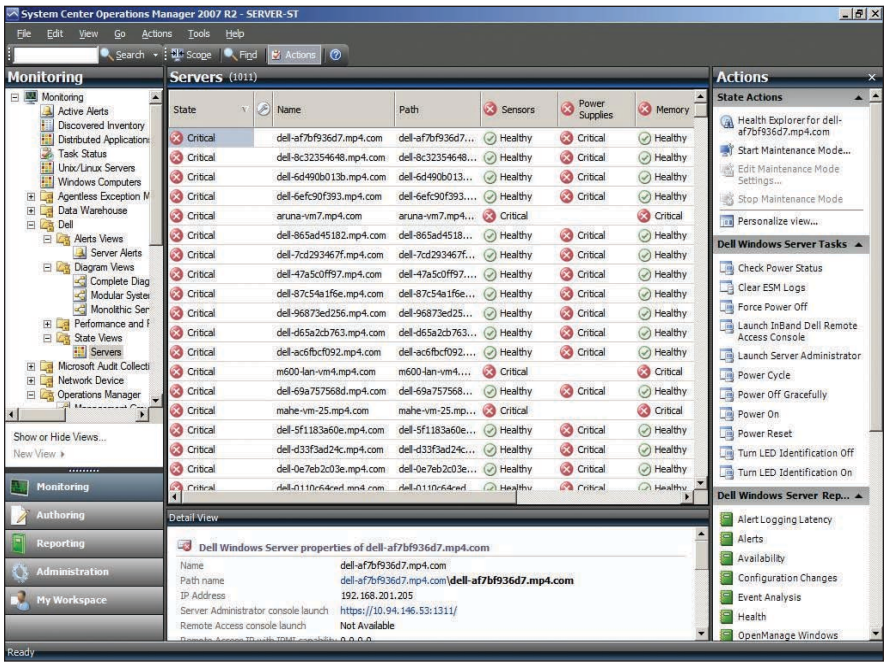

Figure 4. *Example large data center environment in Microsoft System Center Operations Manager 2007 R2*

COMPREHENSIVE SYSTEMS MANAGEMENT

Microsoft System Center provides the foundation for comprehensive systems management through a unified console. As part of the Dell OpenManage Integration Suite for Microsoft System Center, the enhancements provided by Dell MPs and related software utilities enable organizations using SCOM or SCE to incorporate extensive management capabilities for Dell hardware into their existing management infrastructure—helping to simplify and centralize administration, enable proactive systems management, and support robust energy monitoring and scalability. Dell and Microsoft are committed to further simplifying systems management for Dell devices in future generations of the systems management solution stack.

Viswanathan Balakrishnan is a software validation lead engineer on the Dell Business Software Validation team specializing in enterprise and client systems management and virtualization. He has a master's degree in Applied Sciences–Computer Technology from Coimbatore Institute of Technology and an M.B.A. from the University of Madras.

Saravan Kumar is a software validation engineer senior analyst on the Dell Enterprise Software Validation team focused on virtualization solutions.

Mahendran P. is a software tester on the Dell Enterprise Software Validation team.

Vignesh Pandian is a software development adviser on the Dell Partner Engineering team involved in integration development for third-party management consoles. He has an engineering degree in Information Science.

MORE ONLINE
DELL.COM/PowerSolutions

QUICK LINKS

Dell and Microsoft System Center:
DELL.COM/SystemCenter

Dell OpenManage:
DELL.COM/OpenManage

Microsoft System Center:
www.microsoft.com/systemcenter

STREAMING EDUCATION

Montgomery Independent School District estimates that it will reduce help-desk calls by 20 percent, power costs by 20 percent, and total cost of ownership by US$266,000 over eight years by standardizing on Dell™ hardware and Dell Flexible Computing Solutions.

CHALLENGE

Faced with a mix of legacy client and server hardware and an aging cable television system, Montgomery Independent School District wanted to standardize its hardware environment, upgrade its infrastructure, and find a more efficient way to deliver desktops and applications to end users.

SOLUTION

The district standardized on Dell desktops, laptops, servers, and storage systems, including deploying the Dell On-Demand Desktop Streaming™ and Dell Virtual Remote Desktop solutions with Citrix® provisioning, desktop virtualization, and application virtualization software.

BENEFITS

- Upgraded IPTV system saved around US$200,000 compared with the cost of upgrading the legacy system, and reduced IT help-desk calls for video-related issues by 75–85 percent.
- Dell Flexible Computing Solutions help streamline maintenance and are expected to further reduce IT help-desk calls by 20 percent.
- Efficient Dell client systems help save approximately 20 percent on the district's current PC power bill and enable the district to extend its hardware refresh cycle from four years to eight years.
- Total-cost-of-ownership study projects eight-year savings of US$266,000, a 27 percent reduction.

The population of Montgomery County, Texas, nearly doubled between the 2000 and 2007 census counts, and over the next 10 years, Montgomery Independent School District (ISD) is expected to double in enrollment. With the ever-increasing importance of technology in students' lives, the district is challenged to deliver educational technology tools to students and classrooms as efficiently as possible.

When network operations manager George Thornton joined the district, there was little standardization in data center or client hardware. Knowing that the first step toward an effective IT infrastructure is consistency, Thornton recommended that the district switch to a single point of contact for desktops, laptops, servers, and storage. "I have a good history with Dell at other organizations, and the value of the Dell solution is great," Thornton says. The district is now using Dell OptiPlex™ 740 desktops along with Dell Latitude™ E5400 and Latitude E6400 laptops, and has standardized on Dell PowerEdge™ servers and Dell EqualLogic™ PS Series Internet SCSI (iSCSI) storage area network (SAN) arrays in its centralized network operations center.

SAVING ON UPGRADE COSTS

Another area Thornton targeted, with the encouragement of director of technology Steve Bodman, was the district's cable television system. Many of the district's IT help-desk calls were related to the system, and teachers were frustrated to the point that they were no longer using video in the classroom. To help solve these problems, Thornton decided to switch to an IPTV system based on Dell PowerEdge R200 servers with Intel® Xeon® processors running the Microsoft® Windows Server® 2003 OS, along with a Dell EqualLogic PS5000X iSCSI SAN that hosts video of school events for on-demand playback.

The impact of the IPTV system has been monumental—both on student engagement and on the district's bottom line. "The preexisting TV network was one direction only, and original content could not be created or broadcast on it," says Bodman. "Previously, we could not share content across the district. With IPTV, every campus can create unique content for use on the home campus, and other campuses across the district can tune in, even with live broadcasts."

Compared with the cost of upgrading the legacy system, IPTV saved the district around US$200,000. "It would have cost us over a quarter of a million dollars to upgrade the conventional TV infrastructure at all seven campuses," Thornton says. "All of the core server equipment required for IPTV cost us about US$70,000, and we've been able to reclaim a significant amount of rack space. Help-desk calls for video-related issues have decreased by 75 to 85 percent. And we've been running this for about a year with no major issues."

> **"We've had a very good experience with Dell, and the solutions we've put in place will help ensure that we can continue to provide students with the best possible technology."**
>
> —George Thornton
> Network operations manager for Montgomery Independent School District
> January 2010

EMBRACING DESKTOP VIRTUALIZATION

To provide students with a rich desktop experience and help reduce the amount of staff time spent maintaining hardware and patching systems, Montgomery ISD is also embracing desktop virtualization. The district is currently replacing 1,000 PCs in computer labs and classrooms with Dell OptiPlex FX160 desktops with Intel Atom™ processors, and deploying a combination of the Dell On-Demand Desktop Streaming solution (using Citrix Provisioning Server™ for Desktops software) and the Dell Virtual Remote Desktop solution (using Citrix XenDesktop™ software) on Dell PowerEdge M605 blade servers and a Dell EqualLogic PS5500E iSCSI SAN.

The interesting twist is that the district is not streaming the images directly to end-user desktops at the campuses; instead, the images stream to Citrix XenServer™ virtual machines running on PowerEdge M605 blades located in the network operations center. "Twenty-three blades host around 30 virtual machines each," Thornton explains. "So the virtual machines are doing all the processing work, and we're using Citrix XenDesktop to capture keyboard and mouse data and push screen updates to the desktops themselves. This way, we're not traversing the WAN to stream the OS or applications to the end user." Citrix HDX™ technology enables the district to push Adobe® Flash and multimedia content using minimal bandwidth.

In addition, Montgomery ISD is using Citrix XenApp™ software to deliver some applications independently from desktop images. This approach enables users to launch applications from a server rather than having them stored locally or on an image—helping save time for the IT staff by enabling them to deploy those applications only once.

SIMPLIFYING MANAGEMENT AND REDUCING ENERGY USE

Thornton expects the desktop virtualization solution to further reduce the district's IT help-desk calls by 20 percent. Staff will no longer have to visit classrooms and labs to install software and re-image desktops, and virus infections can be quickly remediated with a simple reboot.

Another benefit of the new solution is power savings: Bodman estimates that it will help save around 20 percent on the district's current PC power bill. In addition, because the performance of the virtual desktops is not dependent on client-side processors and RAM configurations, Thornton estimates that the desktops will enable the district to extend its refresh cycle from four years to eight. "A total-cost-of-ownership study projects eight-year savings of 27 percent, or US$266,000," says Bodman. "Although it is still very early in the school year, early results tend to support the notion that this was a very good move for our district."

KEEPING UP WITH GROWTH

Thornton appreciates the fact that the district was able to source the entire virtual desktop solution—both the hardware and the Citrix software—through Dell. He also likes the flexibility the district gets with Dell support. "We have different support contracts with Dell depending on how critical the hardware is," he says. "For the EqualLogic SAN arrays, we have Dell ProSupport for IT with a guaranteed four-hour response time. We've had a very good experience with Dell, and the solutions we've put in place will help ensure that we can continue to provide students with the best possible technology—even with the district growing at more than 7 percent each year."

MORE ONLINE
DELL.COM/PowerSolutions

QUICK LINK

Dell virtual clients:
DELL.COM/VirtualClients

A THINNER, GREENER SOLUTION

A Dell™ Flexible Computing Solution helps the Dutch province of South Holland create a versatile, multipurpose infrastructure while simplifying management and supporting an environmentally conscious approach to IT.

CHALLENGE

The province of South Holland wanted to reduce the environmental impact of its IT infrastructure while increasing end-user and administrator flexibility.

SOLUTION

Dell consultants helped configure a versatile Dell Flexible Computing Solution based on Dell OptiPlex™ FX160 desktops with Intel® Atom™ processors, backed by Dell ProSupport for IT.

BENEFITS

- Dell consultants worked with South Holland to design a versatile, multipurpose solution, and helped deploy 2,100 OptiPlex FX160 systems in a total of nine days.
- Purchasing Microsoft® software licenses through Dell helps save on costs while providing a single point of contact for services, hardware, and software.
- Dell ProSupport for IT provides four-hour response to any issues with the OptiPlex FX160 systems, day or night, 365 days a year.
- OptiPlex FX160 systems help accelerate support, streamline management, and support the province's energy-efficiency goals.

Local governments that encourage citizens to adopt environmentally responsible practices must lead by example—and often, the IT infrastructure is a good place to start. In support of these goals, many local authorities are looking at the benefits that virtual or hybrid clients can deliver.

South Holland is the most densely populated of the 12 Dutch provinces, with more than 3.4 million people living in its 76 municipalities. The administrative center is The Hague, where provincial officials are responsible for everything from road maintenance to the province's environmental impact. The Netherlands Efficiency Action plan—set up in 2007—set strict targets for businesses, including a 40 percent reduction in paper usage and a mandate to cut energy use in all sectors.

Henk Brands, coordinator of software and hardware for South Holland Province, is responsible for buying IT equipment used by more than 2,400 government employees, from office-based desktop users to field staff with laptops and tablets. "IT is critical to our operations, but we had no significant standardization, and the existing technology didn't fit our green agenda," he says. The province wanted to increase the agility of its working environment and use a standardized platform: "We wanted to move to a virtual client solution for greater administrative control, and bring flexibility to the workplace. We saw that an adaptable infrastructure could also minimize our environmental impact," says Brands.

OPTIMIZING DESKTOP VIRTUALIZATION TECHNOLOGY

The province had used virtual clients before, but spoke with Dell about how to extend and optimize its use of this technology. Dell invited the team to its Solution Innovation Centre in Limerick to see the different technologies in action. Then, through a series of design workshops and discussions, Dell and the province came up with an appropriate solution. "We asked Dell consultants to help generate ideas on the best solution for our infrastructure," says Brands. "Once we'd decided on the technology, Dell helped us prepare to roll it out across the region."

South Holland decided to deploy 2,100 Dell OptiPlex FX160 desktops with Intel Atom processors. The Atom processor is well suited for the province's needs because it has a low-power microarchitecture—which not only makes the processor energy

efficient, but also provides excellent multiple-application productivity.

The South Holland team also noticed that the OptiPlex FX160 had key features that were not available in competing products. "We looked at other flexible solutions, but the FX160 provided a total package, with elements such as video, sound, USB connectivity, or dual-display support," says Brands. He was also impressed with the multipurpose design of the OptiPlex FX160: "We can use the Dell OptiPlex FX160 as a standard virtual client, or as a desktop with simple applications installed on each machine. It's a green and flexible solution—perfect for the province."

> **"We can use the Dell OptiPlex FX160 as a standard virtual client, or as a desktop with simple applications installed on each machine. It's a green and flexible solution—perfect for the province."**
>
> —Henk Brands
> Coordinator of software and hardware
> for South Holland Province
> February 2010

STREAMLINING AND SIMPLIFYING DEPLOYMENT

Dell consultants helped design the image used on the Dell OptiPlex FX160 systems. After a series of workshops and design meetings with Brands and his team, they decided on a flexible image based on the Microsoft Windows® XP OS, which Dell delivers preinstalled in each system. Because most of the province's projects are put forward as formal tenders, which can be lengthy and complicated, for the past three years the province has simplified this process with a Microsoft Enterprise Agreement organized by Dell. "By purchasing Microsoft licenses through Dell, we not only save money, but have a single point of contact that we trust," says Brands. "When it comes to projects such as this, my life is a lot easier because we deal with just one company for services, hardware, and software."

Before, during, and after the deployment, Dell consultants went on-site in South Holland to learn about the organization's working environment. By bringing in technical experts at an early stage, Dell helped ensure that the right products were chosen and deployed correctly—which was important, given that 2,100 systems needed to be deployed to multiple sites in The Hague and Leiden within a short period. "Dell has been with us at every stage, and we've benefited from the expertise of its consultants," says Brands. "This support meant we could deploy the first 1,500 OptiPlex FX160s at three sites in just five working days. We deployed an additional 600 units in just four days—much faster than we expected."

PROVIDING A SIMPLE, PRODUCTIVE WORKING ENVIRONMENT

Dell and South Holland's partnership has not ended now that the deployment is complete. Dell not only continues to advise and collaborate with the province on new projects, but also helps protect the province's entire infrastructure, including servers and storage, through Dell ProSupport for IT. This service provides the province's IT department with a four-hour on-site response to any issues with Dell OptiPlex FX160 systems, day or night, 365 days a year.

In addition, some staff members are working on certification to use the Dell Fast-Track Dispatch service, which will help the IT team carry out its own diagnosis according to Dell standards—avoiding the need for Dell technicians to come on-site and allowing trained personnel to quickly order replacement parts. "We've always been impressed with the speed of response we get with Dell ProSupport," says Brands. "Now, with Fast-Track Dispatch, we'll have direct access to high-level technicians and an online parts request facility. This will save time and ensure maximum availability across the province."

The advantages of the Dell Flexible Computing Solution are already being seen across the province. The multipurpose design of the OptiPlex FX160 makes it appropriate for different departments and staff members throughout South Holland, and the system has helped the province achieve high utilization levels to avoid wasted resources. By standardizing on the OptiPlex FX160, South Holland has been able to accelerate support for end users regardless of location, rapidly distribute security and application patches, and dramatically streamline management—providing a simple, productive working environment while simultaneously helping achieve the province's energy-efficiency goals.

MORE ONLINE
DELL.COM/PowerSolutions

QUICK LINK

Dell virtual clients:
DELL.COM/VirtualClients

A BLOCKBUSTER MARRIAGE OF FORM AND FUNCTION

Seeking to maximize mobile productivity, Creative Artists Agency selects the Dell™ Latitude™ Z laptop for its combination of full-featured, energy-efficient performance and elegant design.

CHALLENGE

Creative Artists Agency (CAA) wanted to maximize mobile productivity for all employees by providing videoconferencing capabilities and optimizing laptop battery life.

SOLUTION

Dell Latitude Z laptops with Intel® Core™2 Duo processors offer a sleek design, high performance, full-featured videoconferencing and multimedia capabilities, and long battery life.

BENEFITS

- Intel Core 2 Duo processors provide the power for multimedia tasks, while long battery life helps ensure that CAA agents can keep working even when away from power sources.
- Robust, easy-to-use videoconferencing capabilities combined with Microsoft® Office Communications Server keep agents and executives connected with colleagues and contacts.
- Large 16-inch screen provides an excellent platform for high-definition video.
- Innovative Dell FaceAware™ face-recognition technology helps protect information and conserve power.

When it was time for Creative Artists Agency (CAA) to refresh its fleet of laptops, the company wanted systems that would reflect its commitment to visual aesthetics while delivering full-featured performance. "Just as the architectural design of our headquarters makes a statement about our work, so do our computers," says Michael Keithley, CIO at CAA. "We want products that look great and feature a streamlined design for maximum mobility. At the same time, we need true enterprise-class machines that can ensure that our agents can communicate effectively and access information reliably, wherever they are."

To help meet the company's needs for form and function, the CAA IT group selected Dell Latitude Z laptops with Dell ProSupport for its mobile workforce. "The Dell Latitude Z is the first enterprise-class product that takes design and aesthetics seriously," says Keithley. "It's thin. It's light. And it has a big, beautiful screen. The Latitude Z just nails it. It has pretty much everything you could want from an all-in-one mobile laptop."

Equipped with Intel Core 2 Duo processors, the Latitude Z can deliver plenty of performance for agents' processor-intensive multimedia tasks. At the same time, the primary battery and optional second battery help ensure that those tasks keep running when agents are away from power sources. "The battery life on the Latitude Z is amazing," says Keithley. "It lasts twice as long as I would expect. Our agents will be able to keep working on the road without having to constantly search for power outlets."

FULL-FEATURED VIDEOCONFERENCING AND MULTIMEDIA

The Dell Latitude Z can provide robust videoconferencing capabilities to help CAA agents communicate effectively while traveling. The laptop can be configured with an optional two-megapixel, autofocus Webcam and built-in array microphones, and includes a microphone input jack for mobile headset connectors. "The Latitude Z is a perfect fit for our videoconferencing needs," says Keithley. "With a high-quality camera, microphone array, and speaker system, we can have face-to-face meetings with outstanding audio and video quality. We have standardized on Microsoft Office

Communications Server [OCS] for desktop videoconferencing, and starting a videoconference is simple. With just one click, we can be on a video call with anybody who is part of our network, no matter where they are located. Latitude Z users can also join room-based videoconferences with the same one-click ease."

CAA employees can also use the Latitude Z and Microsoft OCS for telephony, enabling them to choose the most appropriate communication method for each situation. "With the quality of the mics and speakers, the Latitude Z is a viable phone replacement," says Keithley. "By tapping into Microsoft OCS with the Latitude Z, we can give our agents and executives a range of communications options—instant messaging, voice, and video—to enable them to serve our clients better."

The large 16-inch LCD screen of the Latitude Z, meanwhile, will help agents review videos whether they are in the office or on the road. "As part of their jobs, many of our agents need to screen high-definition [HD] video from their computers," says Keithley. "In the past, that task was particularly difficult while traveling—the laptops on the market did not provide sufficient screen real estate or the right aspect ratio. With a large 16-inch screen, the Latitude Z provides a great platform for screening HD video. Video looks gorgeous on that screen. More importantly, the ability to watch HD video directly from a laptop will help our agents be more productive on the road."

INNOVATIVE MOBILE TECHNOLOGY

CAA agents will also use the innovative Dell FaceAware software technology to help protect access to information and conserve energy. Using the optional Webcam, FaceAware scans for the user's presence. If the user's face is not found, the computer locks and activates the power-saving features of the Microsoft Windows® OS. FaceAware can be set to recognize multiple faces so laptops can be shared.

"We've done extensive testing with Dell FaceAware, and it works amazingly well," says Keithley. "The software can even detect if I've turned my head to talk to someone so I can save energy when I'm not working directly on the computer. FaceAware will enable our agents to keep information private by locking when they walk away from their computers, and it will help them stay productive by extending the battery life of their computers while traveling." In addition to supporting videoconferencing and face recognition, the autofocus Webcam can be used for scanning printed materials using the Dell Capture document scanner—a useful feature for traveling CAA agents.

Although most agents won't have time to contemplate the internal components of the Latitude Z, Keithley knows that they will appreciate the advantages of solid-state drives. "The solid-state drives will help the computer boot up faster, run cooler, and produce less noise," says Keithley. "We can also choose a model with a second drive, which gives us the option of installing a second OS or creating a backup drive to protect information. Using solid-state drives is a tremendous benefit. Once you go solid-state, you never go back."

> **"The Dell Latitude Z is the first enterprise-class product that takes design and aesthetics seriously. It's thin. It's light. And it has a big, beautiful screen. The Latitude Z just nails it."**
>
> —Michael Keithley
> CIO at Creative Artists Agency
> January 2010

ENHANCED PRODUCTIVITY ON THE ROAD

The IT group at CAA plans to make the Dell Latitude Z the new standard laptop at the company. According to Keithley, the Latitude Z will help not only enhance mobile productivity but also simplify computing back in the office. "Many agents prefer to use a laptop as their sole computer, and the Latitude Z makes that possible," says Keithley. "The Latitude Z provides the performance for all of our agents' tasks plus the ability to connect to peripherals wirelessly, so agents can connect to large flat-panel displays or other devices without a mess of cords. By combining a smart design with full functionality, the Latitude Z simplifies computing and will help agents stay focused on providing outstanding services to our clients."

MORE ONLINE
DELL.COM/PowerSolutions

QUICK LINK

Dell Latitude laptops:
DELL.COM/Latitude

BUILDING A SCALABLE CLOUD

By migrating its databases to standards-based Dell™ PowerEdge™ servers, cloud computing leader salesforce.com achieves cost-effective scalability and doubles performance while dramatically reducing costs.

CHALLENGE

To accommodate rapid customer growth, salesforce.com needed its global database infrastructure to scale cost-effectively while providing outstanding performance and high availability.

SOLUTION

Dell helped the company migrate its Oracle® databases from a Sun SPARC–based infrastructure to standards-based Dell PowerEdge R905 servers with AMD Opteron™ processors running the Red Hat® Enterprise Linux® OS.

BENEFITS

- Streamlined provisioning has helped cut server deployment time by half.
- Dell servers provide double the performance while saving 10 times the cost of the previous systems, enabling the IT group to increase redundancy and availability.
- Reduced power and space requirements help make room for new, innovative services and customer growth.
- Global partnership helps simplify server deployment and bolster support around the world.

What began as a small San Francisco startup during the dot-com boom is today a thriving global enterprise that is transforming how software is delivered and used by a wide range of businesses. Salesforce.com is the leader in enterprise cloud computing services—sometimes known as software as a service (SaaS) and platform as a service (PaaS). These services enable organizations to manage every part of the customer relationship and provide a platform for developing any type of custom enterprise application.

The company's impressive growth has been great for business, but has also presented challenges for the IT group. Scaling the database infrastructure has been particularly difficult. "The most critical part of the salesforce.com infrastructure is the database layer—as the backbone for our cloud computing platform and customer relationship management services," says David Fearnley, senior director of technical operations at salesforce.com. "We were using Sun SPARC–based servers and the Solaris OS to host our Oracle databases, but it was too costly to scale that infrastructure. We needed hardware that could help us scale more cost-effectively."

The salesforce.com team also needed a global vendor that understood cloud computing. "First of all, we wanted to work with a company that would still be around in 10 years," says Claus Moldt, senior vice president of technical operations at salesforce.com. "We also wanted a vendor that shares our vision for cloud computing. Finally, we needed a global vendor that could supply and support our data centers around the world."

REBUILDING THE DATABASE INFRASTRUCTURE

The salesforce.com team was already using Dell PowerEdge R610 servers to host its application infrastructure, but the IT group still evaluated servers from several hardware vendors. The Dell team could offer not only the hardware but also the partnership that salesforce.com required. The IT group followed up immediately with a proof of concept. "Through our previous relationship with Dell and this proof of concept, we've seen that the Dell team can provide deep engineering assistance, reliable hardware, and extensive support," says Moldt. "In addition, it's clear that the Dell team understands that cloud computing is the future—Dell is even adopting the cloud approach in-house."

> **"The new Dell hardware infrastructure will enable us to build larger database clusters, introduce new cloud computing services, and add more customers all while controlling our costs."**
>
> —David Fearnley
> Senior director of technical operations at salesforce.com
> January 2010

Dell ProConsult services helped to fully validate the Red Hat Enterprise Linux OS as the new software platform for the Oracle databases. "Dell invited our engineers to Dell headquarters so they could see how Dell tested various software stacks," says Fearnley. "As we began to configure the software for our servers, we were impressed with how the Dell team worked with Red Hat to resolve issues and help us create a standardized platform for our databases. Through their extensive testing and their strong relationships with software vendors, the Dell team was able to help us achieve a smooth migration to the new platform."

On an ongoing basis, the Dell team helps to streamline the provisioning of new servers. "The Dell team provides Media Access Control [MAC] addresses and serial numbers prior to the arrival of servers so we can prepare ahead of time. When the servers arrive, our engineers can rack them, install software, and get them up and running quickly," says Fearnley. "Deploying the Dell PowerEdge servers in our facilities is a turnkey operation. We estimate that we have cut our deployment time by half compared with the previous infrastructure."

DELIVERING OUTSTANDING PERFORMANCE AND AVAILABILITY

The salesforce.com IT group selected Dell PowerEdge R905 servers with AMD Opteron processors as the standard hardware platform for the database infrastructure. Moving to industry-standard hardware and software components has helped significantly increase performance and reduce total cost of ownership. "The Dell PowerEdge R905 server enables us to double performance while saving 10 times the cost of our previous systems," says Moldt. "In addition to acquisition costs, we are saving on hardware management and maintenance, software licensing, and a host of other costs. The cost savings will enable us to offer new, innovative services to customers and keep us competitive as more companies enter the cloud computing marketplace."

These savings have enabled the IT group to increase database cluster size and build secondary clusters to help ensure availability. "With the cost savings we achieved by moving to Dell, we were able to build mirrored database clusters so we can toggle customers to secondary clusters during upgrades," says Fearnley. "Now we provide a 'five-minute upgrade,' giving our customers the latest software without interruptions. Dell is helping us deliver on the promise of the always-available cloud."

The Dell servers are also helping the salesforce.com team to conserve power and space. "Moving from a Sun SPARC–based systems infrastructure to Dell PowerEdge servers, we were able to reduce our database infrastructure footprint by 30 percent while still improving performance," says Fearnley. "We have achieved commensurate power savings as well. In the short term, consolidation lets us cut costs. In the long term, it will allow us to expand our IT infrastructure to support additional customer growth without having to rebuild our data centers."

FACILITATING WORLDWIDE EXPANSION

Working with Dell is helping salesforce.com to simplify server deployment and bolster support around the world while delivering a reliable, consistent experience for its customers. The Dell account team also provides regular briefings on its technology road map so the IT group can plan purchases well ahead of time. "We initially selected Dell PowerEdge servers with four quad-core AMD processors for this database project," says Fearnley. "When AMD released a new six-core architecture, the Dell team helped us modify our planning and standardize on that new architecture, moving from 16 to 24 cores per server."

The salesforce.com team now has the cost-effective, scalable infrastructure it needs to move forward. "The new Dell hardware infrastructure will enable us to build larger database clusters, introduce new cloud computing services, and add more customers all while controlling our costs," says Fearnley. "With help from Dell, we can remain a leader in this burgeoning field."

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COMPARING DDR AND QDR INFINIBAND IN 11TH-GENERATION DELL POWEREDGE CLUSTERS

By Munira Hussain
Gilad Shainer
Tong Liu
Onur Celebioglu

Choosing a high-speed, low-latency interconnect can help maximize efficiency in high-performance computing environments. As Dell benchmark tests demonstrate, Quad Data Rate (QDR) InfiniBand fabrics can offer optimal bandwidth, latency, and scalability for clusters of 11th-generation Dell™ PowerEdge™ servers.

The 11th-generation Dell PowerEdge server family incorporates features and functionality well suited for high-performance computing (HPC) environments in terms of architecture, performance, and energy efficiency. These servers are based on the Intel® Xeon® processor 5500 series and Double Data Rate 3 (DDR3) memory linked using Intel QuickPath integrated memory controllers. In addition, the servers include x8 and x16 PCI Express (PCIe) 2.0 slots that double the specified transfer rate from 2.5 GT/sec to 5 GT/sec compared with the previous-generation PCIe 1.0 slots. These slots offer enhanced I/O performance to help reduce some I/O bottlenecks while providing efficient bandwidth and latency for communication-intensive applications.

In HPC clusters, the InfiniBand interconnect can fully utilize the PCIe bandwidth provided by 11th-generation Dell PowerEdge servers. This article outlines some of the advantages of using Quad Data Rate (QDR) InfiniBand for inter-node communication, including several sets of benchmark test results demonstrating the bandwidth, latency, and scalability improvements possible when compared against Double Data Rate (DDR) InfiniBand and Gigabit Ethernet.

INFINIBAND AND MELLANOX TECHNOLOGIES

Choosing an appropriate interconnect is essential to maximizing HPC system efficiency. Slow interconnects delay data transfers between servers, causing poor utilization of the compute resources and slow execution of simulations. For systems with multi-core processors such as 11th-generation Dell PowerEdge servers, interconnect flexibility is critical: because cores can perform different tasks, these systems must support Remote Direct Memory Access (RDMA) along with the traditional semantics of the send/receive model.

By providing high bandwidth, low latency, and extremely low processor overhead, InfiniBand has become a commonly deployed high-speed interconnect in place of proprietary or low-performance solutions. The InfiniBand Architecture (IBA) is an industry-standard fabric designed to provide high-bandwidth, low-latency computing; the scalability to support thousands of nodes and multiple processor cores per server; and efficient utilization of compute processing resources. Mellanox® ConnectX® DDR and QDR InfiniBand adapters and InfiniScale® IV switches offer leading-edge InfiniBand solutions designed to provide up to 40 Gbps of bandwidth between servers and up to 120 Gbps of bandwidth between switches, along with ultra-low application and switch latencies that enable efficient, scale-out compute systems.

BANDWIDTH, LATENCY, AND SCALABILITY BENCHMARK RESULTS

In June 2009, Dell engineers tested a cluster of eight Dell PowerEdge R610 compute nodes with a

PowerEdge R710 head node. Each server was configured with two quad-core Intel Xeon X5550 processors at 2.67 GHz, 12 GB of RAM at 1,333 MHz, and add-in Mellanox ConnectX DDR and QDR InfiniBand host channel adapters using the servers' PCIe 2.0 slots. An unmanaged 36-port Mellanox InfiniScale IV QDR InfiniBand switch provided the high-speed, low-latency fabric in conjunction with OpenSM running on one of the compute nodes. The team used two sets of benchmarks to compare the DDR and QDR InfiniBand fabrics: the Ohio State University (OSU) Message Passing Interface (MPI)–level bandwidth and latency tests, and the NASA Advanced Supercomputing (NAS) Parallel Benchmarks (NPB) suite, which contains a collection of computational fluid dynamics codes and is widely used to evaluate the communication, computation, and scalability characteristics of HPC clusters.[1]

Figure 1 shows the OSU MPI-level unidirectional and bidirectional bandwidth results for each interconnect on an x8 PCIe 2.0 slot. As this figure illustrates, bidirectional bandwidth nearly doubled when moving from DDR to QDR InfiniBand. Figure 2 shows the OSU MPI-level latency results: the latency for small and midsize messages remained almost the same, but the gap increased widely for large message sizes.

Figure 3 shows the speedup over Gigabit Ethernet for both InfiniBand fabrics along with the percentage increase when moving from DDR to QDR InfiniBand, using the NPB Class C Conjugate Gradient (CG), Embarrassingly Parallel (EP), Fast Fourier Transform (FT), Integer Sort (IS), Lower-Upper Symmetric Gauss-Seidel (LU), and Multigrid (MG) applications. Both the CG and IS benchmarks are highly bandwidth sensitive, and therefore showed a significant performance increase when moving from DDR to QDR InfiniBand. The MG benchmark is latency bound with small and midsize messages; as shown in Figure 2, the latency across DDR and QDR InfiniBand is almost identical at these message sizes,

[1] For more information on these benchmarks, visit mvapich.cse.ohio-state.edu/benchmarks and www.nas.nasa.gov/Resources/Software/npb.html.

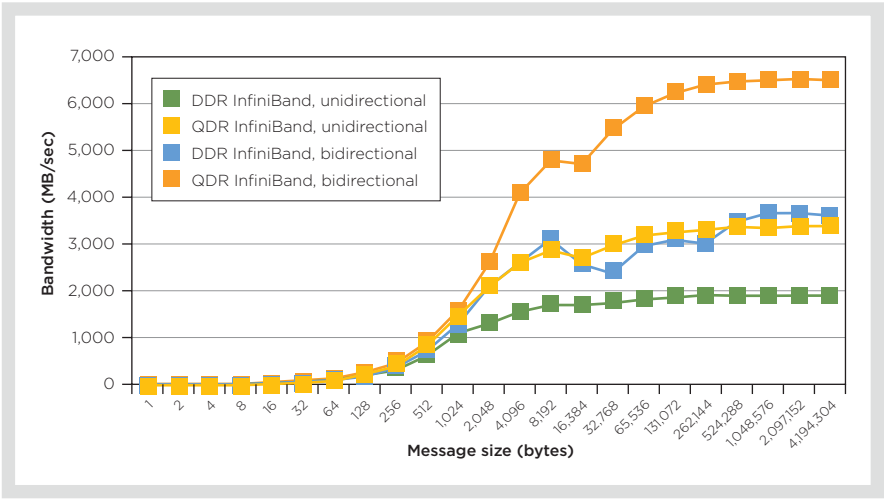


Figure 1. *Unidirectional and bidirectional bandwidth for DDR and QDR InfiniBand in the OSU MPI-level bandwidth tests*

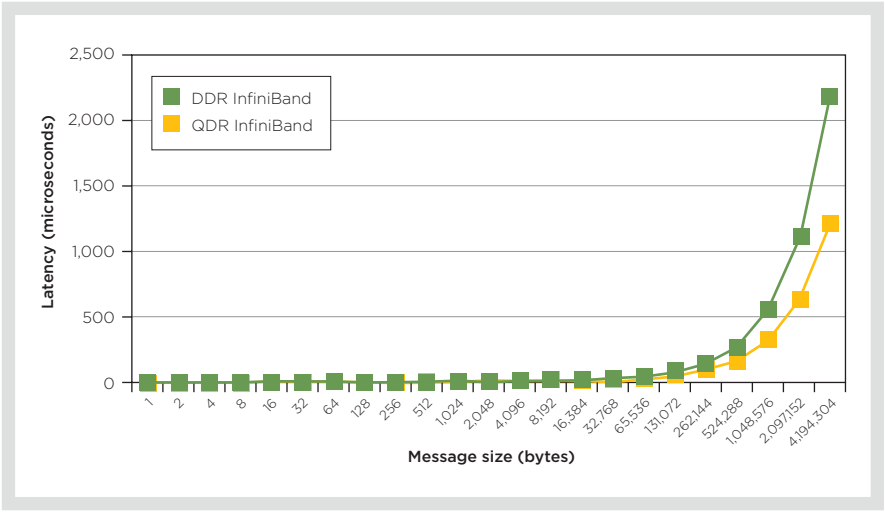


Figure 2. *Latency for DDR and QDR InfiniBand in the OSU MPI-level latency test*

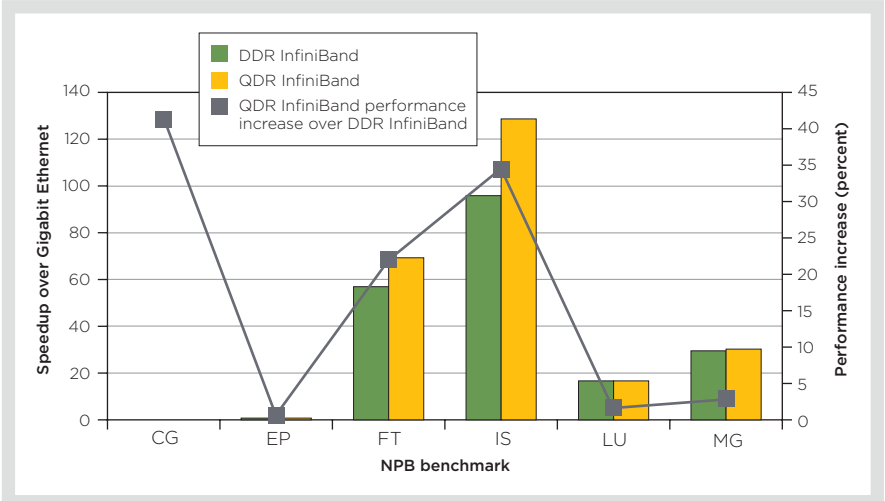
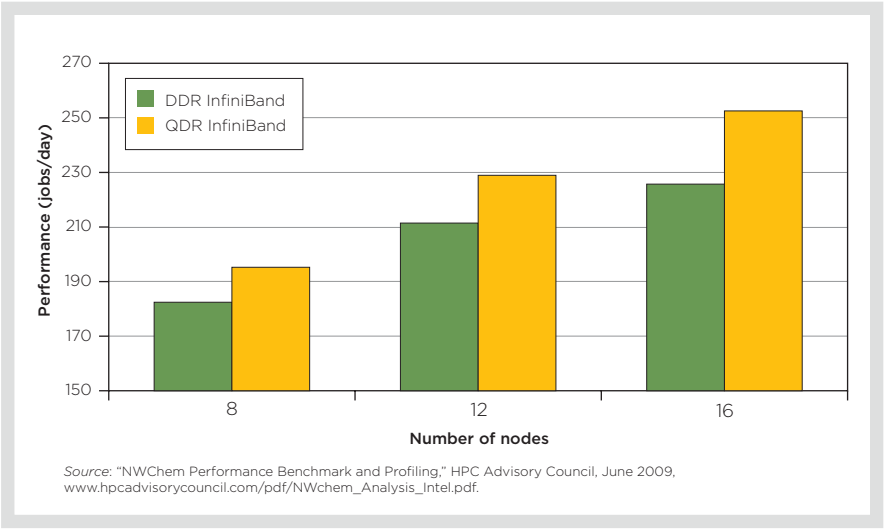


Figure 3. *Speedup over Gigabit Ethernet for DDR and QDR InfiniBand across six NPB benchmarks*

and therefore this benchmark showed minimal improvement when moving from DDR to QDR InfiniBand.

Figure 4 compares the performance increase of DDR and QDR InfiniBand when scaling from four to eight nodes across various NPB benchmark applications. Nearly all of the benchmarks—both communication and computation intensive—showed significant performance increases when scaling to eight nodes. The IS benchmark, which is both bandwidth and latency intensive, showed approximately a 60 percent increase for both DDR and QDR InfiniBand. The CG benchmark, which tests irregular long-distance communication, showed a greater increase when using QDR InfiniBand compared with DDR InfiniBand.



Source: "NWChem Performance Benchmark and Profiling," HPC Advisory Council, June 2009, www.hpcadvisorycouncil.com/pdf/NWchem_Analysis_Intel.pdf.

Figure 5. *Performance for DDR and QDR InfiniBand in the NWChem Siosi7 benchmark when scaling from 8 to 16 nodes*

HPC ADVISORY COUNCIL BENCHMARK RESULTS

The HPC Advisory Council has also published results using the Siosi benchmark from the NWChem computational chemistry package to compare the performance and scalability of DDR and QDR InfiniBand on 11th-generation Dell PowerEdge server clusters. Figure 5 shows the results of a performance scalability test comparing DDR and QDR InfiniBand. In this test, QDR InfiniBand enabled higher performance and scalability than DDR InfiniBand, with the gap increasing with the number of servers: at 16 nodes, QDR InfiniBand provided 12 percent higher performance than DDR InfiniBand.[2]

HIGH-SPEED, LOW-LATENCY CLUSTER INTERCONNECT

When choosing a cluster interconnect, the appropriate fabric can depend on the specific application characteristics, usage, and other factors. As the benchmark tests presented in this article demonstrate, however, using InfiniBand in conjunction with PCIe 2.0 slots on 11th-generation Dell PowerEdge servers can help provide the optimal I/O bandwidth, latency, and scalability to meet typical HPC application requirements.

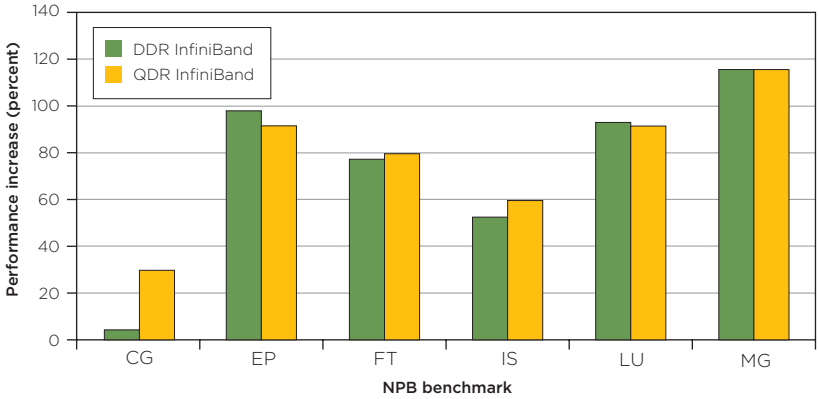


Figure 4. *Performance increases for DDR and QDR InfiniBand across six NPB benchmarks when scaling from 4 to 8 nodes*

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[2] For details on the test configuration and additional results, see "NWChem Performance Benchmark and Profiling," HPC Advisory Council, June 2009, www.hpcadvisorycouncil.com/pdf/NWchem_Analysis_Intel.pdf.

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