SOLUTION BRIEF

VMware® Virtual Desktop Infrastructure

Designing a Scalable Server and Storage Architecture with VMware Infrastructure 3, Dell EqualLogic PS5000XV, and Dell PowerEdge 2950 Servers

Business Challenge

Organizations are constantly looking for solutions that can provide a simpler, more cost-effective approach to managing end user desktops. Managing traditional enterprise desktops today has become increasingly difficult, challenging and costly. Some of the challenges that desktop managers face today include:

- Increasing cost for support and maintenance,
- Rising number of remote and mobile users,
- Greater use of employee-owned computers,
- Application version upgrade patch management,
- Greater focus on the quality of the user experience,
- A greater requirement for hardware and software availability,
- Continuing performance and stability issues,
- Security and compliance adherence, and
- Desktop hardware refresh and operating system upgrades.

This solution brief explains how organizations can use VMware virtualization technologies to provide a virtual desktop infrastructure.

Virtualization as a Desktop Solution

Over the last few years, enterprises have realized the benefits of server virtualization in their datacenters through consolidation and business continuity efforts. Virtualization has simplifies day-to-day administration and reduces management tasks and operating costs, all while maintaining reliability and availability. The success of virtualization in these areas combined with the growing challenge to manage desktops, companies are beginning to look for ways to reap similar benefits in the desktop environment by applying the same technologies.

VMware offers an end-to-end solution called VMware View 3 that organizations use to provide corporate end users with access to virtual desktop machines that are hosted in a central datacenter. This solution enables administrators to leverage the power of VMware Infrastructure 3 along with an enterprise-class connection broker to improve manageability and control, while delivering a familiar desktop experience to end users.

Virtual machine hardware independence, encapsulation and isolation, combined with features such as VMware VMotion, VMware High Availability (HA) and VMware Distributed Resource Scheduler (DRS), make virtualized desktops substantially more agile than traditional physical desktop configurations. VMware VMotion enables the live migration of virtual machines from one physical server to another, with no effect on the running applications.

VMware HA clusters provide continuous service availability in both planned and unplanned system downtime situations. VMware DRS dynamically load balances all of the VMware virtual machines across the entire pool of available resources. This solution also improves manageability, availability and simplifies disaster recovery, and provides for more rapid provisioning and allocation of new desktop and storage resources.

VMware and Dell have created a server and storage design using a building block approach. Each building block has been designed to support approximately 64 desktop virtual machines running a workload that is representative of a user running a common set of business applications.

The building block has been designed according to best practices specific for VMware View environments. They have been pre-sized and tested and can be fine-tuned to meet the specific requirements of each unique environment they will be deployed in.

Benefits of VMware Virtual Desktop Infrastructure

VMware View provides an array of benefits that address common concerns when managing traditional desktop computers.

Streamlined and Simplified Desktop Management

Through VMware View, administrators can configure, deploy and maintain hardware-independent desktop virtual machines from central locations for simpler management and efficient desktop provisioning. The solution reduces the time it takes to deploy a desktop to minutes, optimizing the value of IT resources and improving end user productivity. VMware View Manager 3, a key component of VMware View 3, provides flexible, intuitive desktop management to enable IT administrators to quickly provision and tightly control user access. VMware View Manager allows IT personnel to:

- Manage connections between remote clients and their centralized virtual desktops.
- Automatically provision desktops by using optional "smart pooling" capabilities.
- Maintain the desktop state when the end-user logs out or revert the desktop to a "known" state.
- Provide secure encapsulation via a proxy server so that all connections are completely encrypted.

When desktops are centrally managed in a secure datacenter, patches such as virus scanning software and the other standard security policies are easier. Administrators can lock down access to various network drives or shut a user off instantly when they leave the company. VMware View Manager 3 leverages the "sandbox" capabilities of a virtual machine that is fully contained, isolated from the host operating system, and designed by desktop administrators to be a good citizen of the desktop community.

Administrators can modify memory, processes, and disk resources on a virtual machine with no interruption to a user's workday.

VMware View delivers consistent and scalable IT services which addresses issues remote sites face such as management complexity, inadequate infrastructure and lack of administrative resources.

Complete Desktop Environments for a Familiar User Experience

With VMware View, end users get a complete, unmodified virtual desktop that behaves just like a normal desktop computer, even though the desktop actually resides in a remote location. There is no change to the applications or desktop environment, no application sharing or any re-training required, because it feels and works just like the users' own desktop environments.

Administrators can give end users the ability to install applications; access local devices such as printers, USB devices and other peripherals; customize their desktop environments to suit their needs; access desktops from anywhere; and provision desktops that are more restricted and revert to a known consistent state upon log-off. Users also receive better support with VMware View, because Help Desk technicians can perform tasks in the datacenter that would normally require an on-site visit.

Continuous Availability and Reliability

VMware View extends the benefits of VMware Infrastructure 3 to the desktop, so customers can benefit from reliability, data protection and disaster recovery capabilities that have traditionally been available only for server applications. Because the desktop virtual machine is managed in the same way as other virtual workloads are managed in the datacenter, high availability and disaster recovery can be built into the new design from the beginning.

In many instances, servers carry 24 x 7 support, so desktops residing there benefit as well. Once VMware View encapsulates desktops as virtual machines, the virtual machines become files located on central shared storage. End users can leverage shared storage to backup desktop data. Administrators can also replicate these virtual machine files to another location and power them on inside another set of virtual infrastructure servers. This process is much easier and more reliable than the "zero backup" desktop scenario often seen, or the "boot and pray" disaster recovery method that many companies rely on today.

Automated failover helps to ensure high availability for virtual desktops, while site-wide recovery mechanisms ensure rapid service restoration after an unplanned outage. Most disaster recovery plans only address data retention and server replication but do not have a plan for the desktops. Assuming access to a second datacenter, and additional servers to host virtualized desktops with storage, VMware View (by default) includes the capability

to give desktops the same level of disaster recovery that servers can have under virtualization.

Another use case is the capability of utilizing snapshot technology for the virtual machine, allowing live, point-of-process, disk and memory roll-back points. A "snapshot" or "moment in time" image of the virtual machine can be saved and subsequently restored in minutes.

Improved Security and Compliance

With VMware View, controlling access to confidential data is easier, because all virtual desktops reside in a central location. This enables stronger policy enforcement and tighter data security. Tools available today can ensure that a virtual machine is only available to the user if patch requirements are met. Integration with RSA SecurID® enables support for two-factor authentication, while strong network encryption protects data in transit. These features can help reduce the risk of data leakage and malicious code intrusion while also helping to ease regulatory compliance burdens.

VMware View eliminates vulnerabilities inherent in the distributed desktop environment (USB, DVD, CDR drives) by moving the virtual machine into the data center. Datacenter security is higher than that of the user PC, as well. With that assurance, meeting and maintaining corporate standards and compliance is easier.

Lower Total Cost of Ownership (TCO)

Organizations use VMware View to replace traditional PCs with virtual desktops that run on servers in the data center. Desktop management costs decline because technical requirements to manage user hardware are reduced.

In addition, VMware View provides better desktop control and management, helping to reduce the total cost of ownership (TCO) for your desktop infrastructure and extending the life cycle of your hardware. Organizations today are transforming the way they manage their desktops, replacing traditional PCs with centralized virtual desktops that can be more effectively managed and controlled. VMware View provides an array of benefits that address the common concerns when managing traditional desktop computers today.

VDI Server and Storage Building Block

VMware, in conjunction with Dell, has created a scalable server and storage architecture for VMware View environments. The configuration uses a building block approach for sizing VMwrare View environments built on VMware Infrastructure 3, Dell PowerEdge 2950 servers and Dell EqualLogic PS5000XV iSCSI storage arrays.

Each building block has been designed and tested to support 64 virtual desktops (8 per core) running a workload commonly referred to as a "knowledge" or "information worker." This worker profile runs a set of business applications common to many corporate desktops today and is an ideal candidate for desktop virtualization.

The worker profile and associated applications have been identified as a result of research done by VMware to study the most common type of desktop worker. In particular, the configuration was designed and tested with the following applications:

- Microsoft Word
- Microsoft Excel
- Microsoft PowerPoint
- Adobe Acrobat
- Microsoft Internet Explorer
- WinZip
- McAfee VirusScan

Figure 1 below represents the building block that has been designed and tested to support 64 virtual desktops running a target worker profile described above. Key specifications of the building block are the following:

- 64 virtual desktops per VMware ESX™
- Dell PowerEdge 2950
  - ESX 3.5 Update 2
  - Dual quad-core Xeon @ 2.67GHz
  - 32GB RAM
- 2 x 1GB NICs for virtual machine network
- 2 x 1GB NICs for iSCSI network
- EqualLogic PS5000XV storage array
- 146GB SAS drives
  - 2 x 410GB LUNs
  - 32 virtual desktops per LUN

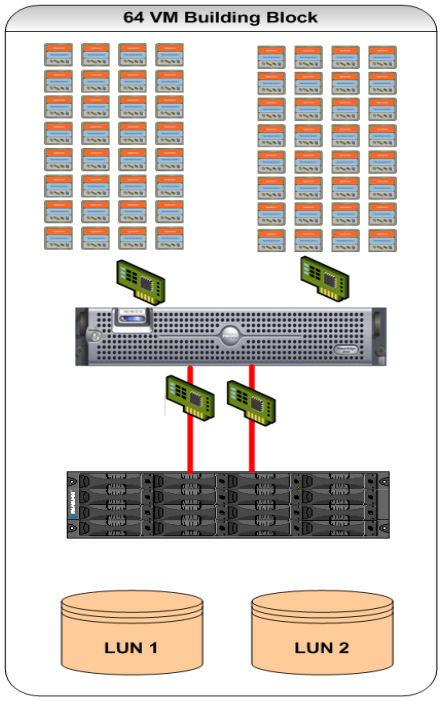

Figure 1. 64 Virtual Desktop Building Block

VMware View for Desktop Environments

The solution can be broken down into four primary layers, each one building on the one below it and all layers working together to provide a complete platform for VMware View deployment for mid-size enterprises. The four layers of the solution are:

- Layer 1: VMware Infrastructure 3 software
- Layer 2: Dell EqualLogic PS series array
- Layer 3: Dell PowerEdge servers
- Layer 4: VMware View Manager and Clients

Layer 1: VMware Infrastructure

The building block configuration was designed and tested using VMware Infrastructure 3 as the foundation to create a virtualized desktop infrastructure. VMware Infrastructure 3 abstracts processor, memory, storage and networking resources into components that can serve multiple virtual machines, providing greater hardware utilization and flexibility.

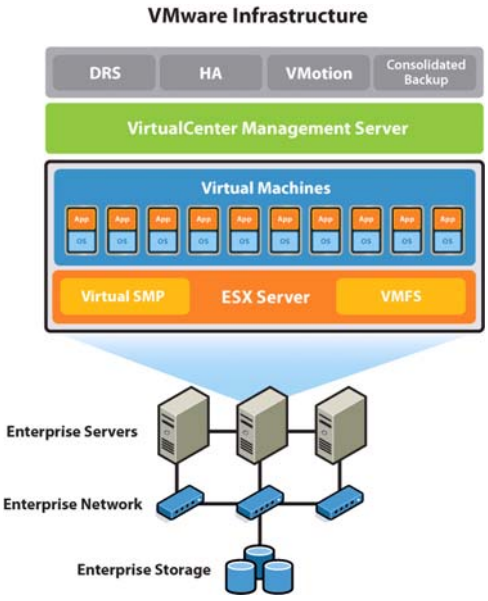

Figure 2. VMware Infrastructure

Figure 2 above describes the core components of VMware Infrastructure. The VMware View configuration presented here was built as follows:

Enterprise storage:

- Dell EqualLogic PS5000XV storage array
- 146GB 10K SAS drives
- Storage Array Firmware v3.2.4

Enterprise network:

- VLAN 1: Virtual machine network
  - 2 x 1GB NICs
  - 32 virtual machines per NIC
- VLAN 2: iSCSI network
  - 2 x 1GB NICs

Enterprise servers:

- Dell PowerEdge 2950
  - Dual quad-core Intel Xeon at 2.67GHz
  - 32GB RAM
  - 4 x 1GB NICs (2 for virtual machine network, 2 for iSCSI)

ESX Server:

- VMware ESX Server 3.5.0 (build 110268)

Virtual Machines:

- Windows XP Pro SP2
- 1 vCPU
- 512MB RAM

vCenter Server:

- Dell PowerEdge 1850
- vCenter Server 2.5.0 (Build 104263)

VMotion/DRS/HA/VCB:

- Enterprise features for virtual machine management and availability

Layer 2: Dell EqualLogic PS5000XV iSCSI Storage

Solution storage is based on the Dell EqualLogic PS Series storage subsystem. iSCSI provides an ideal solution for VMware View environments by providing cost-effective storage with excellent performance. The PS5000XV array provides a high-performance iSCSI SAN built on fully redundant, hot-swappable enterprise hardware. Built-in software functionality includes automatic load balancing, snapshots and replication, multi-path I/O, consistency sets and more. The storage building block was designed with the following characteristics:

Table 1. Storage building block characteristics

VMs per LUN	32
Disk drive	146GB SAS
RAID type	RAID 50
iSCSI initiator	ESX s/w initiator

The approach used to size storage for the 64 virtual machine building block includes:

1. Estimate performance requirements through the collection of disk performance statistics on a user's desktop systems during normal operation.
2. Estimate capacity requirements by determining the size of the system drive to be allocated to each virtual desktop.
3. Choose a disk drive type by taking into consideration performance, capacity and interface requirements.
4. Choose a RAID level after understanding workload (heavy or light) characteristics and how the application performs I/O.
5. Choose an iSCSI Initiator – hardware or software.

The storage sizing for this solution was for the use of full clones, where each virtual desktop will have its own persistent virtual disk.

While this is a simple solution to size and deploy, it can result in greater cost as the solution scales up with additional building blocks. To reduce the cost of VMware View storage as the solution scales, there are additional options:

- **Snapshots:** Dell EqualLogic storage arrays have the ability to take a snapshot of a LUN at a point in time and provide it to VMware ESX as a new writable datastore.
- **VMware View Composer:** VMware View Composer is one of the new components included in VMware View 3 and it provides the following benefits when deployed in a VMware View environment:
  - Reduce storage cost and management by up to 90 percent.
  - Reduce desktop provisioning from 15 minutes to just seconds.
  - Manage hundreds of desktops from a single central image, retaining user settings when updating or patching service packs, application updates or even OS upgrades.
  - Roll back instantaneously, enabling customers to streamline management and guarantee that all user systems are up to date.

Administrators should apply these technologies carefully, because they may potentially affect performance by inducing a greater load on a more limited set of shared storage resources. A classic storage sizing tradeoff exists between configuring storage to optimize cost and capacity at the expense of performance. The performance requirements as defined by our workload in this study indicates that the aggregate I/O workload of a virtual desktop infrastructure is non-trivial and "bursty," requiring storage sizing to be considerate of both cost and IOPS performance. For information on deploying storage solutions based on VMware View Composer, please contact your VMware or Dell representative.

Layer 3: Dell PowerEdge Servers

Dell PowerEdge servers have set the industry standard for simplifying operations, driving leading-edge price performance and delivering business-relevant IT solutions. Dell continually delivers server technology designed for high performance, ease of use and overall efficiency. Commonality is built into the PowerEdge server family with the specific goal of simplifying management and maintenance, while reducing cost and complexity. PowerEdge servers are quick to deploy and easily integrate with VMware Infrastructure 3. Figure 3 below shows the test environment using three building blocks based on the Dell PowerEdge 2950.

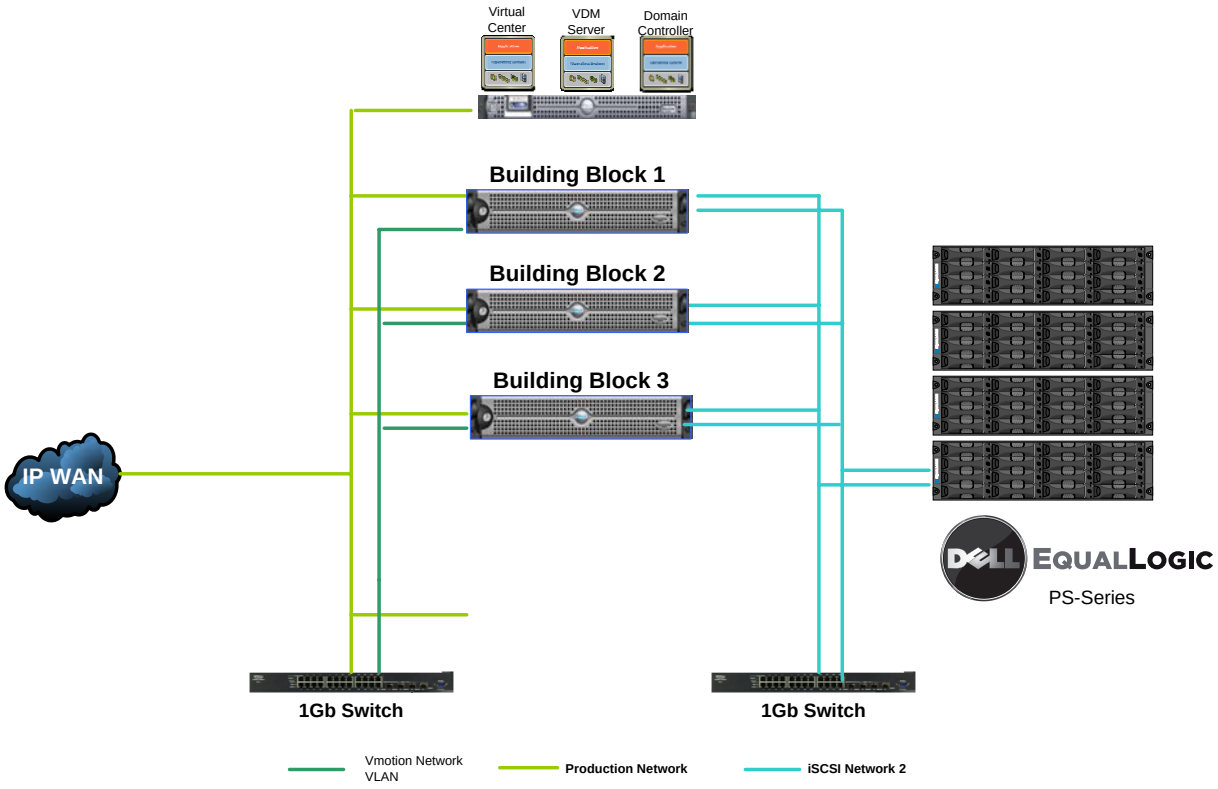

Figure 3. Test environment

The building block used the Dell PowerEdge 2950 with dual quad-core processors (Intel Xeon 2.67GHZ) and 32GB RAM. This configuration provides a nice balance of overall server hardware cost with enough compute power to support 64 virtual desktops running our target worker profile.

Selecting the proper server for VDI environments requires careful consideration and should pay attention to the following criteria:

Cost per virtual machine – The right server selection provides a balance between overall cost and number of virtual desktops it can run in a production VMware View environment.

Number of VMware ESX servers to manage – Cost per virtual machine should also be balanced with the number of VMware ESX servers required to support the virtual desktop environment. Very large VMware View deployments may favor servers with more processor and memory to allow more desktops per VMware ESX host and hence fewer VMware ESX hosts to manage.

VMware ESX license costs – For VMware View environments, dual socket quad-core servers typically provide a balance between cost and performance.

PCI slots – Ensure the server has enough PCI slots for network and storage connectivity for high availability and resiliency.

VMware VMotion compatibility – Ensure all servers in the VMware View environment have compatible processors for VMware VMotion, especially if the VMware View servers will be part of an existing VMware ESX cluster.

Layer 4: VMware View Manager and Clients

The final layer in this solution is VMware View Manager and clients. Administrators run an enterprise desktop management server that connects remote clients to centralized desktops and manages virtual desktop environments. VMware View Manager is an enterprise-class desktop management server that securely connects users to virtual desktops in the datacenter and provides an easy to use web-based interface to manage VMware View environments.

VMware View Manager uses existing AD infrastructure for authentication and user management. The solution integrates with VMware vCenter to manage virtual desktops running on VMware ESX hosts.

VMware View Manager has the following main components:

- **VMware View Client** – Locally installed software application that communicates with VMware View Connection Server to allow users to connect to their virtual desktops.
- **VMware View Portal** – Web-based version of View Client supported by multiple operating systems and browsers.
- **VMware View Administrator** – Web application that is the primary mechanism for configuring VMware View Manager, and managing users and desktops.
- **VMware View Connection Server** – Software that acts as a connection broker and provides management and user authentication for virtual desktops.
- **VMware View Agent** – Software that installs on desktop virtual machines and enables features such as RDP connection monitoring, remote USB support, and single sign on.

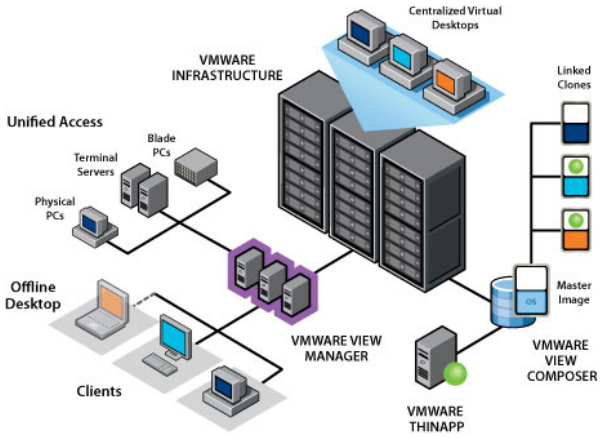

Figure 4. High-Level View of a VMware View Manager Environment

Each virtual desktop had the following configuration:

- 1 Virtual CPU
- 512 Mbytes Memory
- 10 GB Disk Space (C-drive > operating system and applications)
- Microsoft Windows XP SP2
- VMware View Agent
- Microsoft Office 2003

Performance

Extensive performance testing was done using VMware View Performance test program along with VMware vCenter, esxtop, and the Dell EqualLogic performance monitoring tool.

Figure 5 shows VMware ESX memory utilization averaged approximately 19GB. With memory page sharing, the VMware ESX was able to reclaim approximately 13GB of memory over the course of a 4-hour test run. The graph shows actual memory consumption and page sharing increasing and decreasing slightly during the test run as virtual desktops open and close common applications. As the test progresses, there are more common pages found in memory for all the virtual machines. This shows efficiency in the memory being used.

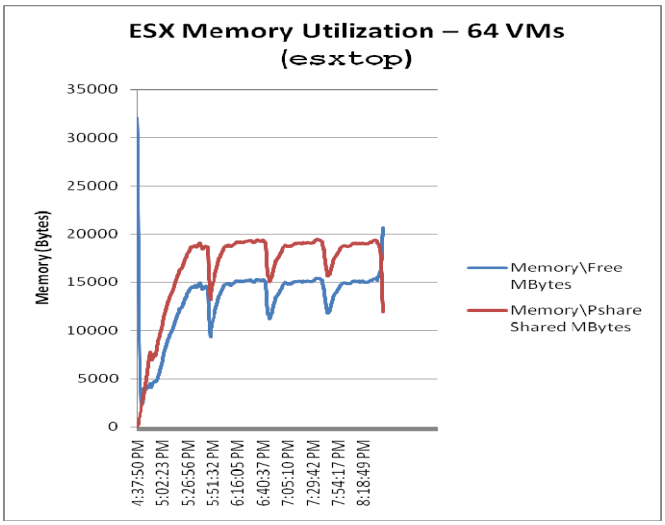

Figure 5. VMware ESX server memory utilization measured by esxtop when running 64 virtual desktops on a single Dell PowerEdge 2950 with 32GB RAM

To measure disk performance requirements, the Dell EqualLogic performance monitoring tool was used. When running 64 virtual desktops against the EqualLogic PS-5000X array, the following performance metrics were observed (see Figure 6).

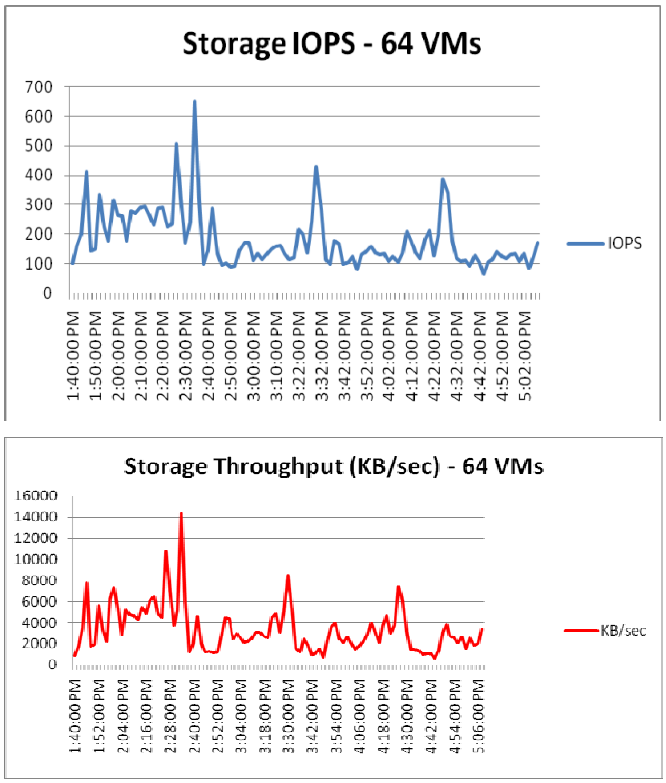

Figure 6. Storage IOPS and throughput measured on the Dell EqualLogic PS5000XV

Actual IOPS during testing saw averages of approximately 185 with peaks at 650. Throughput average was approximately 3530 KB/s with peaks at 13733 KB/s. One of the benefits of the EqualLogic PS Series array is that VMFS Datastore volumes are virtualized, that is, striped across all disk drives in the array, thus distributing the aggregate virtual desktop workloads across all storage resources. Additional performance capacity can be added simply by expanding the SAN with an additional storage array (seamlessly added to the EqualLogic Group). The PS Series will automatically re-distribute the data volume and disk I/O across the additional controller, network ports, memory cache, and disk spindles.

Deploying and Scaling the Solution

Designing and testing a server and storage building block for a typical worker profile allows organizations to use the configuration provided as a reference for their own deployments. The building block has been sized and tested according to both VMware and Dell best practices. Ideally, administrators should deploy the first building block as a proof-of-concept with a group of pilot end-users. This provides the opportunity to take baseline performance measurements on the system to ensure sizing estimates are in line with actual usage in production.

As additional building blocks building blocks are deployed into the VMware View environment, the following design considerations should be kept in mind:

- **VMware configuration maximums:** Always check the latest configuration maximums, particularly in large VMware View deployments.
- **VMware ESX cluster design:** Decide whether the VMware ESX hosts running the virtual desktop environment will form their own cluster, or whether they will be part of an existing cluster containing other server workloads.
- **VMware vCenter instances:** Consider managing virtual desktops by their own dedicated VMware vCenter instance, or by an existing vCenter instance that may already be managing other third-party systems.

Conclusion

Organizations must support a wide variety of users – local, mobile and remote. These users normally access sensitive information assets on a range of equipment, including desktop, laptops and unmanaged personal computers, making it difficult to support end users in a consistent and secure manner. VMware View addresses the desktop management challenges by tightening the control of corporate assets and simplifying desktop management. This approach extends powerful VMware Infrastructure 3 capabilities such as business continuity and disaster recovery to the desktop, streamlines desktop management to reduce operations costs and increase control, and delivers complete desktop environments with greater application compatibility.

Combining the benefits of VMware virtualization, the cost-effective and reliable Dell EqualLogic PS5000XV storage subsystem, and 64-bit Dell PowerEdge 2950 servers provide a very robust platform for desktop virtualization. The "building block" solution is designed to optimally support desktop environments in multiples of 64 and can easily scale as the environment and business need grows.

Take the Next Step

For more information on this solution, including the VMware View reference architecture guide, please contact your VMware or Dell representative.

VMware, Inc. 3401 Hillview Ave., Palo Alto CA, 94304. USA.
Tel 877-486-9273 Fax 650-427-5001