Using Local Disks in a VMware® View™ Deployment

WHITE PAPER
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Introduction

Built on the industry-leading VMware virtualization platform, VMware® View™ enables you to deliver rich, personalized virtual desktops to any device with all the benefits of centralized enterprise desktop management. The VMware View portfolio of products lets you run virtual desktops in the datacenter while giving end users a single view of all their applications and data in a familiar, personalized environment on any device at any location.

VMware View transforms the way you use and manage desktop operating systems. You can deploy desktop instances rapidly in secure datacenters to facilitate high availability and disaster recovery, protect the integrity of enterprise information, and remove data from local devices that are susceptible to theft or loss. By isolating each desktop instance in its own virtual machine, you eliminate typical application compatibility issues and deliver a more personal computing environment.

Storage Virtual Appliances (SVA) are ideal for designing high-end, clustered virtual iSCSI SANs that leverage the storage resources of VMware ESX servers (internal disks, DAS) and turn them into a powerful virtual SAN in minutes. Users can configure shared virtual storage to maximize capacity, reliability, and performance at a fraction of the cost of traditional network storage. The introduction of storage virtual appliances for VMware ESX hosts, described in this paper, gives you another choice. You can configure and deploy multiple virtual SANs created from local attached disks.

In a branch office or small/medium office deployment, virtual servers and desktops reside in the branch office. Using VMware ESX, you can transform the servers needed for a View deployment into easily administered virtual machines that provide continuous application availability, and the SVA storage virtual appliance (SVA) can transform the unused disks in your ESX host’s internal storage into an iSCSI target. This configuration enables you to take advantage of rapid, automated restart and failover without the cost or complexity of solutions that require physical servers and shared storage infrastructure.

This paper focuses on a test that simulates the work patterns of a branch office with workers using VMware View desktops with SVA storage.

This paper is not a user guide for the virtual SAN appliance nor is it a best practices document. We do not cover such topics as WAN optimization or storage virtualization. This paper does provide a proof of concept based on 25 virtual machines so that corporate buyers or IT administrators can be informed when making decisions about future product purchases or VDI deployment using local storage.
Storage Virtual Appliance

A Storage Virtual Appliance (SVA) unlocks the processor and data storage resources of the ESX server and provides a virtual SAN that enables datastores to be shared in the same way as an external shared storage system. It is a software SAN approach allows your organizations to grow as you need. This also allows you to test the functionality of storage on your network without getting the physical hardware. Virtual SAN appliances are available from a number of storage system vendors. For links to information on these SVAs, see the Resources section. Typically, you must purchase a license for each SVA. The appliances are designed to be compatible with ESX and you can cluster them using multiple ESX hosts so the iSCSI SAN can withstand the loss of one or more hosts.

Besides creating a virtual SAN for a VMware View deployment, as we did for the tests described in this paper, you can use a SVA in a number of other ways. For example, you can use a SVA to try out the functionality of a full-featured storage system before purchasing the physical storage devices, or you can use a SVA to create a portable storage demonstration.

A SVA is ideal for designing clustered virtual iSCSI SANs that use the storage resources of VMware ESX hosts (internal disks and direct attached storage), turning them into a powerful virtual SAN in minutes. You can configure shared virtual storage to maximize capacity, reliability, and performance at a fraction of the cost of traditional network storage.

Software-Based SAN Compared to Hardware-Based SAN

The SVA-supported SAN we discuss in this paper is in most respects functionally equivalent to a traditional SAN. A SVA creates a shared storage node using resources that already exist inside the host running ESX. You can cluster multiple SVA nodes to transform existing server storage into a clustered storage system that you manage as a single SAN. With such a configuration, you can use all ESX advanced features that need shared storage, such as VMware High Availability (HA), vMotion™, VMware Distributed Resource Scheduler (DRS), and VMware Site Recovery Manager.

Use Case 1: Using a Single Virtual SAN Appliance

If your branch office has a limited budget and can afford only a single virtual storage appliance, you can plan for high availability or disaster recovery by clustering two production ESX hosts into an HA cluster group. However, this only protects against the failure of n-1 servers in the cluster. There is no HA for the nth server. Furthermore, the loss of that server terminates all VMs on the n-1 servers. It is a risky deployment to any ESX cluster with more than 2 nodes. The cost savings of not having the second SVA instance probably will not justify the potential risks to the organization that could result in disasters or emergencies themselves.

Use Case 2: Using Multiple Virtual SAN Appliances Clustered into a Virtual SAN

You can run clustered software-based SANs using a group of internal drives on a specifically qualified set of blades or servers, essentially creating a virtual SAN. If you have two SVAs and the host running one SVA fails, the management software in the remaining SVA moves all processing for the logical drive to the remaining SVA on the physical server that is still running. The key thing to differentiate from the previous use case is the storage failover in this use case is transparent with no downtime. The virtual machines from the failed server may need to reboot with HA, but no storage recovery is needed.
Key Drivers for Using Virtual Desktops in Branch Offices

In a traditional branch office setting, workers, using either thin clients or legacy PCs, require access to the same services as those at the headquarters. These services may include supply chain management, inventory monitoring, order placement, customer service, maintenance of accounting records, and so on. Typically, a branch office either lacks full-time IT resources or cannot maintain the same level of security as the headquarters, so it is difficult to prevent data loss from various endpoints. Although it is vital that IT systems deliver the expected features and performance, at the same time, the network needs to be secure, reliable, and easy to maintain, ideally requiring no on-site IT knowledge. In addition, companies must ensure that their branch offices comply with the same regulations that apply to their main offices.

Compliance

Most companies using traditional desktop PCs are unable to comply with broad legal discovery orders because they do not archive electronic content in such a way that they can search and retrieve it in a timely manner. A properly configured VMware View deployment enables companies to prepare for legal contingencies and meet regulatory requirements.

The key drivers for deploying virtual desktops are that they simplify compliance and address audit concerns in protecting consumers’ private financial data (Gramm-Leach-Bliley Act of 1999), hardening email policy and such practices as the archival lifecycle of email .PST files (Sarbanes-Oxley Act), securing email messages containing protected health information (HIPPA), and many others. Furthermore, with the recent Supreme Court mandate for the storage of electronic records, email management becomes more complicated. If you use VMware View, your mission-critical desktops can operate centrally, as shown in Figure 1, and leave no footprint in the physical hardware at remote locations.

Figure 1: VMware View Components
PST File is Important

Most data loss issues in enterprises are the result of employees’ mistakes and carelessness rather than malicious hacks from outside. If a data breach or loss occurs, the affected organization needs to show its customers, auditors, and regulators that it has addressed the problem.

In leakage cases, email is a popular focus for data loss protection. Besides the problems of social security numbers, credit cards numbers, or other data flying out in messages or attachments, a corporation is held responsible if an email .PST file — the Microsoft Outlook personal storage file — is lost. For example, a well-known financial firm paid a record $15 million fine to settle a Securities and Exchange Commission probe into its failure to preserve email. In VMware View deployments, sensitive and structured data is stored and maintained in a secure environment where it is easier to back up critical files.

In dealing with data loss caused by physical misplacement or theft, VMware View gives your organization the benefits of server-based computing without the limitations of shared services technologies.

Decentralizing the Benefits of VMware View

Companies with high-bandwidth WAN connections often prefer to run their View desktops in a central datacenter. For other companies, delivering branch office services from their central datacenter can be quite a challenge because of bandwidth constraints, support, and other issues. In addition, VMware View is designed for use with SAN storage, which may be beyond the budget for a branch office. A SVA that has appropriate vendor support can bridge the gap, providing the SAN storage that View requires more economically than a physical storage array.

You can manage a branch-office View installation across your WAN with only a small fraction of the bandwidth you would need if you hosted View desktops in your central datacenter. And a branch-office installation of View can provide many of the key benefits of a centralized installation, such as easier patching, improved management, better security, and decreased power consumption.

For users with certain access profiles, you can allocate persistent desktops — dedicated desktops that retain all of the users’ documents, applications, and settings between sessions. Retention of user data cannot be guaranteed when you perform certain linked clone operations, such as recomposition, refreshing, or rebalancing on the desktops in a pool. To minimize the possibility of data loss, you should not store user data on the same virtual disk as the operating system. You can specify an alternate location for desktop user data when you set up the linked clone.

**Figure 2: Configure User Data Disk in VMware View Administrator**
VMware View provides options for either persistent or non-persistent desktops, based on user profile, and makes it easy to store mission-critical data in a separate virtual disk file on central storage. This means that if the desktop crashes or reboots, it leaves no local footprint. Users can access their virtual desktops remotely from traditional PCs, thin clients, or repurposed computers, using a remote display protocol. Users who access only non-persistent desktops are allocated any desktop currently available in the pool, which may differ between sessions. For branch office temporary or contract workers, a desktop is assigned dynamically each time the user connects.

Test Environment

For proof of concept purposes, we created 25 virtual machines using VMware View and stored them on a SVA data volume. We tested them under two workloads — one designed to simulate a power user and one designed to simulate an office worker.

We used two quad-core Dell PowerEdge 1950 servers as our core ESX hosts and managed them using vCenter. We used one ESX host for the VMware View server and client components, running in virtual machines. We used the other ESX host to run multiple Windows XP virtual machines, which were the View desktops.

SVA Configuration

In our tests, we ran an HP LeftHand VSA to create a virtual SAN node on one of the Dell hosts, using resources including disk drives, cache, processors, and controllers that already existed on the hosts we used to run the virtual machines. In our tests, we did not deploy multiple nodes clustered together, though you can use LeftHand VSAs in this way to transform existing server storage capacity into a virtual storage system. You can then manage that system as a single iSCSI SAN. The SVA can support multiple datastores to be shared across ESX hosts (a storage cluster) if needed in your deployment. The SVA provides its storage management functionality as a software platform running within a virtual machine.

For small business sites or branch offices, a SVA simplifies the configuration and management of storage for its iSCSI SAN.
Within the central management console virtual machine, the LeftHand VSA provides an integrated view including performance monitoring and policy settings for the datastores as an alternative to a general-purpose iSCSI SAN. In this lab configuration, the data volume we used to create the SVA iSCSI SAN was 240GB. Some storage virtual appliance support up to 2TB per server.

Figure 4: SVA Lab Configuration in VMware vCenter

**Test Configuration**

- Certified virtual appliance (VSA2)
- VSA central management console (VSA-cmc) to install a highly available SAN without additional hardware
- HA and DRS features enabled (LHCluster HA Cluster)
- Desktop pool creation using VMware View 3 linked clone to create persistent and non-persistent desktops for branch office groups (VSA-xxx-###)
- System response time tested by simulating and automating user interaction
System Configuration

- Server Hardware: Two Dell PowerEdge 1950 servers with quad-core Intel Xeon E5410, 2 x 6MB cache, 2.33GHz, 1333MHz FSB, 32GB of RAM
- VMware ESX running on both hosts with one virtualSAN appliance on one host
  - Test 2 ESX setup with VMware HA
  - LeftHand Networks Virtual SAN Appliance version 8.0 installed and configured as the iSCSI SAN on one of the ESX hosts
- VMware Virtual Infrastructure 3 Enterprise, including:
  - VMware ESX Server V3
  - VMware VirtualCenter 2
  - VMware DRS
  - VMware HA
  - Microsoft Windows 2003 Server SP2 running VMware View 3.0
- Virtual desktops with the following configuration:
  - Microsoft Windows XP Professional SP2 installed on 25 virtual machines
  - 10GB virtual hard disk
  - 1GB RAM
  - Using both full clone and linked clone configurations
Workload Design

We used a workload based on scripts created using AutoIT (see the Resources section for a link). The scripts simulate a user environment, with the following applications:

- AutoIT v3 — Software used to run the workload.
- Microsoft Word — Open, minimize, maximize, and close the application, write words and numbers, save modifications.
- Microsoft Excel — Open, minimize, maximize, and close the application, write random numbers, insert and delete columns and rows, copy and paste formulas, save modifications.
- Microsoft PowerPoint — Open, minimize, maximize, and close the application, conduct a slide show presentation.
- Microsoft Outlook — Open, minimize, maximize, and close the application, send email messages.
- Internet Explorer — Open, minimize, maximize, and close the application.
- Windows Media Player 11 — Open and close the application, play back WMV files.
- Adobe Reader 8.0 — Open, minimize, maximize, and close the application, browse PDF files.
- McAfee Virus Scanning — Real-time scanning.
- PKZIP — Open and close the application, compress large files.

Duration

We ran three iterations of the test routine.

Note: A real world use case may involve more desktops and pools and may involve more iterations of workloads. However, the data collected in our tests can be used to extrapolate the overall impact of higher numbers and to develop a strategy for determining a branch office model appropriate for your needs.

Test Profile

We configured desktop pools to represent what a small branch office deployment might look like. We created individual user accounts in Active Directory and assigned them to specific groups. We also gave each group an entitlement to a VMware View Manager desktop pool.

In a non-persistent pool, users may be connected to different desktops each time they log in. If you have a properly configured user environment, persistence is not an issue because user data is be stored in a location that is subject to corporate backup policy.

A persistent desktop, on the other hand, ensures the individual gets the same desktop at each login.

Executive staff, HR, and accounts payable and receivable groups require different applications and full individual control over their desktops. Thus, members of these groups need persistent, independent desktops. For profiles such as contractor, support, or training, the applications used for daily operations are generic and common in nature. Considering these characteristics, we allocated the non-persistent pools using linked clones for faster provisioning.
### Table 1: Small Branch Office Sample Profile and Desktop Pool Design

<table>
<thead>
<tr>
<th>ACTIVE DIRECTORY GROUP</th>
<th>NUMBER OF USERS</th>
<th>DESKTOP PERSISTENCE</th>
<th>TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive staff</td>
<td>3</td>
<td>Persistent</td>
<td>Full clone Independent</td>
</tr>
<tr>
<td>HR</td>
<td>2</td>
<td>Persistent</td>
<td>Full clone Independent</td>
</tr>
<tr>
<td>Finance</td>
<td>2</td>
<td>Persistent</td>
<td>Full clone Independent</td>
</tr>
<tr>
<td>Field sales</td>
<td>4</td>
<td>Persistent</td>
<td>Linked clone</td>
</tr>
<tr>
<td>Marketing</td>
<td>3</td>
<td>Persistent</td>
<td>Linked clone</td>
</tr>
<tr>
<td>Contractors</td>
<td>3</td>
<td>Non-persistent</td>
<td>Linked clone</td>
</tr>
<tr>
<td>Support</td>
<td>3</td>
<td>Non-persistent</td>
<td>Linked clone</td>
</tr>
<tr>
<td>Training</td>
<td>5</td>
<td>Non-persistent</td>
<td>Linked clone</td>
</tr>
</tbody>
</table>

The provisioning time for linked clones is significantly shorter than that for full clones after the first linked clone is created. This time difference is expected because each virtual machine that is a full clone requires its own full copy of all the data in the template from which it was created. Only a small fraction of the data is copied when View creates a linked clone. In the branch-office setting, View deployments use limited datastores to store the virtual machines. For this SVA validation, a ratio of 24 virtual machines to one datastore or LUN gave us one datastore per cluster. We created all of the linked clones from the same parent virtual machine.

![Figure 6: SVA Desktop Pool View in VMware Virtual Center](image)

VMware View Composer is aware of the available data storage, view02 in our demo example, defined by SVA. It clones a replica of the parent image to each datastore for use by the pool. Because of the size of the replica, it takes more time to create the replica than to create the subsequent linked clones. Once View copies the replica to each datastore, it does not need to copy that replica again for the same pool or any future pools based on the same parent.
Deployment and Testing Sequence

We took the following steps to set up and run our workload tests:

1. Set up the virtual SAN appliance.

   After you create a virtual SAN appliance, you can present virtualized volumes to hosts as a general-purpose iSCSI SAN by creating authentication groups that set security policies for the virtualization of target volumes within a management group. Any system with LAN connectivity can be a SAN client.

2. Set up HA for local high availability.

   To provide for high availability, you can set up VMware HA using two ESX hosts, one of which hosts the virtual SAN appliance.

3. Prepare 25 virtual machines, using both independent clones and linked clones in View 3.0, and match them to the appropriate Active Directory profiles.

4. Run the workload script. Each workload iteration required nearly 1 hour.

   1. Run the boot state test with three iterations. Boot the virtual machines gradually, at 10-second intervals.
   2. Run three more iterations for the steady-state test.

5. Consolidate and analyze data.

   - Use ESX performance monitor or esxtop utility data on CPU, memory, and storage I/O.
   - Export application response time.
   - Use the performance monitor in the SVA management console to measure storage volume usage.

Performance Results

We began the test process using 25 virtual desktops running Windows XP Professional SP 2 on our Dell PowerEdge 1950 host. We allocated 1GB of memory to each virtual desktop.

Figure 7 shows the performance data displayed by the ESX performance monitor. You can gather additional performance data from the SVA performance monitor for a quick system analysis.

![Figure 7: VMware ESX Performance Monitor Screen Shot During Workload](image-url)
Figure 7 displays the combined work load measures during boot and steady state. The load spikes up at the beginning of the boot process then maintain around 70 percent capacity usage in resources.

**VMware View Building Block System Utilization**

The following graphs show the system resource usage for CPU, memory, and storage during the workload iterations.

**CPU**

![Figure 8: VMware ESX Performance Chart Showing CPU Utilization During Workload](image)

The above graph shows the CPU utilization in ESX running at about 50 percent of its capacity.

**Memory**

![Figure 9: VMware ESX Performance Chart Showing Memory Utilization During Workload](image)

Memory usage was approximately half of the memory capacity, as shown in Figure 9. In production environments, organizations commonly aim for 70 percent to 80 percent memory usage. Therefore these memory usage results indicate the server can probably host more desktops than we used in our tests. To improve memory utilization, the ESX Server host automatically transfers memory from idle virtual machines to virtual machines that need more memory. ESX clears this memory before reallocating it, thus enforcing isolation between virtual machines. You can use the reservation and shares parameters in the configuration for the ESX host to allocate memory preferentially to important virtual machines. This preferentially allocated memory remains available to other virtual machines if the preferred virtual machine is not using it. The workload performance chart shows the benefits of memory sharing across multiple virtual machines.
SVA Storage Utilization

To calculate total storage I/O operations, we used the following formula:

Total storage I/O operation per second (IOPS) requirement = (sum of all max IOPS/number of destops tested) x number of virtual desktops

For example:

8000 total max IOPS = (800 sum of max IOPS / 100 desktops tested) x 1000 virtual desktops

The Figure 10 shows results after the first 20 minutes of a workload run. Some spikes seen in the chart are caused by heavy virus scanning activities and multimedia disk access in the randomized virtual machine workload. The average IOPS is around 239 IOPS, which is slightly less than 50 percent of the performance capacity, indicating that we are not approaching the limits of the SVA-supported iSCSI SAN. We could have used the additional storage for the virtual disks of additional virtual machines or made it available to other servers on the network, rather than using it only for our ESX hosts. From a storage management perspective, the only requirement is that we ensure an adequate number of direct attached storage drives are available so the SVA can allocate physical blocks to logical blocks as needed.
ESX System Utilization

Figure 11: CPU Utilization Before and After the Workload (Boot State)

Figure 11 shows system utilization on the ESX host running the VMware View servers and a small pool of virtual machines. The average CPU utilization is near 75 percent.

Figure 12: CPU Utilization in Steady State

Figure 12 shows that as the workload starts in each virtual machine and enters a steady state, CPU utilization on the ESX host is relatively low, near 25 percent.
Application Response Time in Seconds

Figure 13: Desktop Virtual Machine SVA-con-003 Comparing Response Time with SVA and SAN hardware

Figure 13 shows the average application execution time from one of the virtual machines in the contractor pool – SVA-con-003. These times represent the amount of time it took to open, close, or save a document. The graph does not show the amount of time an application was minimized or being worked on. Because of the random nature of the workload, applications were minimized during parts of the test run, not simply opened, worked on, and closed. The delta between what we saw in this SVA test and what we have seen in previous SAN testing for a configuration with 25 virtual machines is not notable. The one obvious difference is WMV media file playback, which shows an average 12 percent overhead on the SVA configuration.
Conclusion

The scalability test results using SVA can help you estimate the server infrastructure required to provide a branch office with a positive and cost-effective user experience. The application response time and server performance charts show each ESX host can easily support up to 32 Windows XP virtual desktops with the workload we ran.

SVAs offer additional configuration options, such as configuring multiple SVA nodes into a storage cluster. As SVAs join to form a cluster, they examine the total amount of direct attached storage discovered on each ESX host. The SVA management software then automatically creates a cluster wide storage pool in which each SVA storage module is allocated the same amount of disk space — equal to the smallest amount of storage found in any individual SVA pool. Exploring these options was beyond the scope of this paper.

Backing up desktop PCs using tape backup in many branch or small offices can be a cumbersome task. By centralizing desktops using VMware View and upgrading management features, you can create a fully redundant, highly available virtualized desktop environment and server infrastructure for your branch offices.

Deploying VMware View with a SVA provides a fast path to building a controlled virtual desktop infrastructure in a branch office and, at the same time, helps save IT administration costs, reduce datacenter complexity, and increase ROI in times when budgets are tight.

However, you should take into account the risks of physical server failure. You can guard against these risks with a storage backup plan using VMware Consolidated Backup and disaster recovery plan when you plan your branch office configuration. Based on the test results provided in this paper, you can explore your requirements and the additional options of clustered SVA storage to develop a configuration that best fits your situation.

Resources

“Anywhere Data Is Powerful; Data Everywhere Is Dangerous”

RAWC workload

“SANitize DAS to Enhance Virtual Infrastructure “
http://www.virtual-strategy.com/VSM-Labs/Lefthand-VSA.html

VMware View Reference Architecture Kit
http://www.vmware.com/resources/techresources/1084

Virtual SAN appliances are available from the VMware Virtual Appliance Marketplace
http://www.vmware.com/appliances
About the Author

Cynthia Hsieh is a senior technical marketing manager in the desktop solutions group at VMware. Hsieh’s background includes position in product management at Wyse, Trend Micro, Oracle, and Yahoo.

Acknowledgments

The following people assisted in the testing and preparation of this report:

Jason Bloomstein is a staff engineer in the VMware application development group, specializing in storage management solutions for virtual infrastructure. Bloomstein’s broad knowledge was very helpful as we planned the SVA configuration for the project. Before coming to VMware, he spent nine years at Veritas Software as one of the original developers of the market-leading Veritas high availability solution.

Fred Schimscheimer is a senior technical marketing manager in the desktop solutions group at VMware where he specializes in storage technologies and workload simulation programs. Fred Schimscheimer’s background includes positions at Network Appliance, Veritas, and Oracle.

Also special thanks for Mason Uyeda’s guidance and leadership to the direction and completion of the paper.