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Executive summary

Built end-to-end with HP solutions and innovation, HP ConvergedSystem 242-HC StoreVirtual is a virtualization platform for VMware® vSphere that combines powerful compute, highly available storage, HP-supported hypervisor, and management capabilities into a single, scale-out appliance. The compact 2U/4-node form factor allows midsize and enterprise customers to quickly virtualize a variety of workloads ranging from OLTP databases to virtual desktops. The ConvergedSystem 242-HC is ideal for virtualization projects where simplicity, predictable performance, and low cost are key and includes the following features:

- A converged solution with industry-leading software-defined storage and x86-based computing platforms with robust VMware vSphere integration.
- Non-disruptive scalability supports more client provisioning when and where it is needed.
- Wizard-driven startup enables complete deployment of virtualized compute and shared storage infrastructure in under 15 minutes.¹
- Stretch cluster capabilities provide business continuity by keeping virtual desktops and applications online during appliance, rack-level, or site-wide outages.
- Flexible disaster recovery is made possible via replication from one hyper-converged system to another or to a low-cost server running HP StoreVirtual VSA software.
- Centralized management of compute, storage, and virtual machines from inside VMware vCenter Server alleviates the need for specialized server, storage, or virtualization expertise.

This document provides test results and sizing guidelines for a virtual desktop environment using the HP ConvergedSystem 242-HC StoreVirtual with Evaluator Group’s IOmark-VDI benchmark tool.

Target audience: IT administrators and solution architects who plan to deploy a virtual desktop environment solution with HP ConvergedSystem 242-HC StoreVirtual appliance. The reader should have a working knowledge of VDI, as well as hyper-converged systems.

This white paper describes testing performed in March 2015.

Note
The test results in this paper were audited from the Evaluator Group using their IOmark-VDI benchmark tool. Download the report here.

Introduction

As companies look to update their end user computing strategy with a virtual desktop infrastructure (VDI), IT administrators must be aware of the specific demands VDI places on their data center, and specifically on the storage infrastructure, which has historically been the largest expense in a VDI deployment. Storage performance and capacity are critical, and both of these must be at a price-per-user that provides better ROI and value than current physical desktop models.

One of the hottest trends in virtualization hyper-converged architectures unify both virtual and physical hardware components into a single entity that are managed and deployed as an entire system rather than multiple different components. A hyper-converged system is ideal for a VDI deployment for several reasons:

- Cost is always a concern with VDI as you do not get the same benefits of physical hardware consolidation that server virtualization provides. As a result, the cost per user needs to be as low as possible to be attractive to companies that are looking to deploy a VDI solution.
- Traditional VDI deployments are usually SAN-based that drives up the cost of implementing a VDI environment. A hyper-converged system uses software-defined storage that creates a SAN from local disk within a server, so there is no separate SAN infrastructure to implement, reducing the storage costs.

¹ HP internal testing, March 2015
VDI workloads are very different from server virtualization workloads and most of the time companies do not want to mix the two together on the same physical infrastructure. A hyper-converged system is a complete virtual environment without any other dependencies that can be implemented separately from an existing server virtualization environment. As a result, this allows you to segregate your VDI and server virtualization infrastructures and keep the physical infrastructure separate while combining the management of both under a common framework.

Properly sizing a VDI environment can be very challenging, as you must find the optimal balance of all physical resources while being able to avoid user slowdowns during periods of peak activity. If you under-provision the storage, user experience suffers and if you over-provision resources, you are needlessly driving up costs and wasting resources. A hyper-converged system is architected with the perfect balance of physical resources to remove the guesswork that often occurs eliminating costly sizing mistakes from happening.

A key architecture decision for any VDI environment is whether the virtual desktops are persistent or non-persistent. With persistent desktops, users have the ability to customize their operating systems and save settings from session to session. While persistent desktops provide end users a close-to-physical-desktop experience, there are higher storage infrastructure costs to support this model. With persistent desktops, there can be significant redundancy in the data that is stored, particularly OS images. Non-persistent models address these costs by eliminating redundant data and by limiting how much customization is saved to an end user's desktop.

Whether deploying persistent or non-persistent desktops, most VDI environments must be designed to support two very different workloads that can manifest themselves on a daily basis: boot storm and run time. These two workloads have very different I/O characteristics. Run time (AKA steady state) is the standard operating environment for a typical user during a typical day. Depending on the user, this may involve running office productivity applications such as Word processing, spreadsheets, and email. Run time workloads are often heavy write workloads (80 percent writes).

Boot storms (AKA login/logoff storms) occur when a large number of users attempt to simultaneously log into their systems. This can create extreme I/O demands on the storage array; care needs to be exercised to design the right storage solution to ensure boot storms do not cause significant degradation in the end-user experience. A third scenario is a virus scan storm, which can be viewed as similar to boot storm with slightly less I/O requirements. Boot storms are often heavy read workloads (80 percent and more reads) with peak I/O requirements.

This paper describes the test results recorded from benchmarking both persistent and non-persistent users with a run time (steady state) use case, to simulate the worst case I/O demands users may encounter. The tests were done with an HP ConvergedSystem 242-HC StoreVirtual in a virtual desktop environment. The IOmark-VDI benchmark tool is selected as the test engine because it provides a typical real-world workload and maximum efficiency for testing a storage system.

**Tested environment**

The tested environment on the HP ConvergedSystem 242-HC StoreVirtual for client virtualization consists of the following key components:

**HP hardware**

- HP ConvergedSystem 242-HC StoreVirtual appliance (K2Q49A0), which includes:
  - 4 compute/storage nodes (2U chassis)
  - 8 Intel® Xeon® E5-2680 v2 Processors (2.8 GHz, 10-core, 20 MB cache) (2 CPU/node)
  - 64 16 GB PC3L-12800R (DDR3-1600) Dual Rank x4 PC3L (256 GB/node)
  - 16 hard drives, 1.2 TB, 6 GB SAS, 10K SAS (4 x 1.2 TB/node)
  - 8 solid state disks, 400 GB, 6 GB SATA (2 x 400 GB/node)
  - 8 10GbE SFP+ networking ports (2/node)
  - 8 1GbE RJ45 management ports (2/node)
  - 4 1GbE RJ45 iLO ports (1/node)
  - RAID levels: Network RAID 10 (using disk RAID 5)
- HP 6600-24XG Networking Switch (J9265A)
- HP 5900AF-48G Networking Switch (JG510A)
Software
- HP ConvergedSystem 242-HC System nodes (4X)
  - HP StoreVirtual VSA 2014 (LeftHand OS 11.5)
  - VMware vSphere ESXi 5.5 Update 2
- Management virtual machine (Windows®)
  - HP StoreVirtual Centralized Management Console (CMC)
  - VMware vCenter Server 5.5 Update 2

IOmark-VDI setup
- IOmark-VDI tested volumes
  - 10 12 GB volumes under test
- IOmark-VDI infrastructure volumes
  - 10 25 GB volumes used for IOmark target (client) virtual machines
  - 1 25 GB volume used for IOmark master virtual machine

Environment diagram
Figure 1 shows the tested environment. The storage connectivity is 10GbE iSCSI. Each node uses two 10GbE links to an HP 6600 Switch, for a total of eight connections. The iSCSI connections are highlighted in gray. Best practices are followed for the StoreVirtual cabling. Jumbo Frames are not enabled in this testing, with MTU rates set to default at 1,500.

Networking (LAN) connectivity for infrastructure services is highlighted in green. Each node uses one 1GbE link to an HP 5900 Switch, for a total of four connections.

VMware vCenter Server is required to run the complete benchmark workload with IOmark-VDI. VMware vSphere 5.0 or later is supported. Version 5.5 Update 2 is used for this testing effort.

Time synchronization is vital to the testing effort. Time synchronization using NTP is required for all virtual machines and is recommended for the vSphere physical hosts.

Figure 1. Tested environment diagram
Logical diagram

Figure 2 shows a logical representation of the tested setup. All volumes are distributed across all four nodes of the system, where each node has read/write access to all of the provisioned volumes. The HP StoreVirtual VSA is configured using default settings. Each node is configured to be identical, with matching networking and iSCSI properties. All volumes provisioned are also enabled for Adaptive Optimization (AO).

A single Windows management virtual machine is used for running VMware vCenter Server and HP StoreVirtual Centralized Management Console (as seen in figure 2, Node 1).

This is the table that describes the Volumes provisioned in the test environment.

Table 1. IOmark-VDI volumes

<table>
<thead>
<tr>
<th>Volume</th>
<th>Quantity</th>
<th>RAID/size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TestLUN-n</td>
<td>10</td>
<td>Network RAID 10 @ 125 GB</td>
<td>Volumes used for run time workload testing</td>
</tr>
<tr>
<td>IOmarkVDI-n</td>
<td>10</td>
<td>Network RAID 10 @ 25 GB</td>
<td>Volumes used for IOmark-VDI infrastructure</td>
</tr>
<tr>
<td>IOmark-master</td>
<td>1</td>
<td>Network RAID 10 @ 25 GB</td>
<td>Volumes used for IOmark-VDI infrastructure</td>
</tr>
</tbody>
</table>

Note

In this testing, core infrastructure networking services, such as DHCP, NTP, and DNS are the only services not being hosted by the HP CS 242-HC StoreVirtual.

Figure 2. Tested logical diagram
Testing and reporting methodology

The testing methodology used the Evaluator Group’s IOmark-VDI benchmark tool. IOmark-VDI is a storage-specific benchmark that tests VDI environments from a storage perspective. The benchmark results were captured through IOmark-VDI. For more information about IOmark-VDI and the audited test report, refer to iomark.org.

Test results

For more detailed information on the following run time test results, refer to Interpreting results.

Run time results with IOmark-VDI

As seen in table 2, the final run time results are shown as audited by the Evaluator Group.

Table 2. IOmark-VDI run time results

<table>
<thead>
<tr>
<th>Volume</th>
<th>User count</th>
<th>Workload type</th>
<th>Average total response time (ms)</th>
<th>I/O response times @ 30 ms</th>
<th>Capacity used for testing (TB)</th>
<th>Capacity per user (GB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 MLC SSD @ 400 GB, 16 10K HDD @ 1.2 TB = 7.6 TB (RAID 5 + Network RAID 10) total useable capacity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fully provisioned</td>
<td>320</td>
<td>Heavy</td>
<td>16.71</td>
<td>90.68%</td>
<td>6.72</td>
<td>21</td>
</tr>
<tr>
<td>Linked clone</td>
<td>640</td>
<td>Standard</td>
<td>16.71</td>
<td>90.68%</td>
<td>2.17</td>
<td>3.4</td>
</tr>
<tr>
<td>Fully provisioned</td>
<td>640</td>
<td>Standard</td>
<td>16.71</td>
<td>90.68%</td>
<td>6.72</td>
<td>21</td>
</tr>
</tbody>
</table>

HP StoreVirtual Centralized Management Console

As seen in table 3, the average and maximum IOPS are shown from the performance monitor within the HP StoreVirtual CMC. The results are collected during the final audited IOmark-VDI run time test run.

Table 3. IOmark-VDI run time workload

<table>
<thead>
<tr>
<th>VDI user</th>
<th>User count</th>
<th>Workload type</th>
<th>Max. IOPS</th>
<th>Average IOPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fully provisioned</td>
<td>320</td>
<td>Heavy</td>
<td>14,901</td>
<td>10,814</td>
</tr>
<tr>
<td>Linked clone</td>
<td>640</td>
<td>Standard</td>
<td>14,901</td>
<td>10,814</td>
</tr>
<tr>
<td>Fully provisioned</td>
<td>640</td>
<td>Standard</td>
<td>14,901</td>
<td>10,814</td>
</tr>
</tbody>
</table>

Interpreting results

- **User count:** The maximum user count observed is not limited by the available storage IOPS. For the user count, the limiting factor observed is the average response times for all IOPS. As the user count increases, response times also increases and eventually reaches the 30 ms limitation that is outlined in the Evaluator Group benchmark guidelines.
- **I/O response time:** This is the average for all VDI application response times measured during the run time test. The benchmark criteria for the Evaluator Group states that a passing test is 70 percent of response times for all IOPS must not exceed 30 ms. In this HP CS 242-HC StoreVirtual testing, 90.68 percent of all IOPS come in under 30 ms. At 320 fully provisioned heavy users, the average total response time of the completed IOPS is 16.71 ms.
- **Fully provisioned and linked clone:** A VDI user may be configured to run in one of two modes. A linked clone is a copy of a master virtual machine, and the OS image is linked from a master image. A linked clone user normally does not retain its differential data. A fully provisioned user is where the guest OS resides on the same device with the user profile data, just like a physical desktop. Fully provisioned users require a larger storage profile to store differential data.
- **Linked clone:** The linked clone results are derived from the fully provisioned heavy workload test. The user count is reflected by 2X the fully provisioned heavy user count.
• **Workload type:** All the workloads are taken from the Evaluator Group’s IOmark-VDI benchmark test suite. The I/O profile for heavy and standard users in IOmark-VDI are the following: the workload averages 12.52 IOPS per heavy user and 6.26 IOPS per standard user.

• **Capacity/user in GB:** This number can vary greatly and typically grows over the course of an individual user desktop session. For a linked clone, the starting point is 3.4 GB. For a fully provisioned user, the starting point is 21 GB. Over time, these numbers will grow to larger values.

• **Storage capacity:** At 320 heavy users or 640 standard users, a fully provisioned configuration consumes approximately 6.7 TB of capacity or 87 percent of the total useable capacity. The IOmark-VDI infrastructure VMs are hosted within the appliance, which consume an additional three percent of capacity. Over time, these numbers will grow to larger values, making capacity a limiting factor for fully provisioned users.

• **Run time workload:** Run time workloads vary quite differently from boot and login storms. Run time tests involve typical business applications that generate different I/O patterns over time. During normal run time workloads, the I/O pattern shifts toward a higher write ratio (80–90 percent) because the majority of the traffic will be for user OS cache writes and profile updates.

• **Adaptive Optimization (AO):** Adaptive Optimization moves the hottest blocks within the workload to the Tier 0 for maximum performance. During the HP CS 242-HC testing, 95.7 percent of all I/O is seen in the Tier 0.

• **Network RAID:** Network RAID is the redundancy system used by LeftHand/StoreVirtual OS for configuring volumes across all the storage nodes. Network RAID 10 is the default data protection level and is used in this testing. Network RAID offers superior availability but impacts usable capacity and write performance. When using Network RAID 10, the amount of allocated space is increased by a factor of two.

### Summary

The HP ConvergedSystem 242-HC StoreVirtual is optimized for virtualization and simplified management. Designed from the ground up with proven storage, server, networking, and management, the HP CS 242-HC provides robust performance for a wide variety of VDI workloads. With profound integration with VMware and HP StoreVirtual architecture, the HP CS 242-HC StoreVirtual provides the sizing and scaling capabilities needed for client desktop virtualization solutions.

The HP CS 242-HC StoreVirtual is a single 2U/4-node chassis that combines all required hardware ready to deliver the necessary I/O performance and workload agility to virtualized environments. With the HP CS 242-HC, this hybrid model allows for Adaptive Optimization to effectively provide VDI users a superior desktop experience. IOmark-VDI benchmark tests show that while running heavy workloads with maximum user counts, the HP CS 242-HC delivers excellent I/O performance and low response times generating passing tests results. The HP ConvergedSystem 242-HC StoreVirtual provides a flexible scale-out, simple platform with capable performance to build on a variety of VDI solutions.

### Resources

- HP ConvergedSystem
- HP Client Virtualization
- Evaluator Group [evaluatorgroup.com](evaluatorgroup.com)
- [iomark.org](iomark.org)

To help us improve our documents, provide feedback at [hp.com/solutions/feedback](hp.com/solutions/feedback).

Learn more at [hp.com/go/storevirtual](hp.com/go/storevirtual)