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2000 Persistent VMware View VDI Users on Dell EMC SCv3020 Storage

Dell EMC Engineering
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A Dell EMC Reference Architecture

Revisions

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Executive summary

Dell EMC™ SC Series storage arrays are modern, mature, and constantly evolving. With the ever-changing workload demands that businesses face today, it is essential that SC Series arrays continue to advance to keep pace. The architectural changes we incorporated into the recent Storage Center OS (SCOS) 7.2 release, allows us to face these workload demands head on. The newest model of the SC family is the SCv3020. This model is target for smaller workloads or organizations while still delivering the majority of the features of the other models in the SC Series line.

The results show the SCv3020 excels at delivering low latency I/O under load. The maximum steady state performance exceeded 50,000 IOPS at just under 1.25ms of latency. Peak IOPS during the boot phase were just under 70,000 at under 1.25ms of latency.

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1 Introduction

Whether you're building a private or hybrid cloud, a big data analytics center or a secure OLTP platform, Dell EMC SC Series arrays give you quick, strong return on investment by optimizing, accelerating and protecting the data that's most important to your business goals.

SCV3020 builds on the success of previous generation SC Series arrays with a fully upgradable, more scalable hardware platform powered by the robust SCOS 7 operating system.

All-flash and hybrid SSD/HDD configurations can revolutionize the speed and impact of your mission-critical applications. The ability to apply write- and read-intensive SSDs within the same volume, plus add an ultra-dense HDD tier at any time, gives SCV3020 flexibility to target a variety of mixed-workload performance requirements. You can easily evolve from one configuration to another without having to replace drives.

For the tests performed in this document, all hardware was updated to the newest, generally available firmware from the manufacturer.

1.1 Objectives

The primary objective of the testing effort is to demonstrate the performance and scalability of the Dell EMC SCv3020 array. By providing a baseline for performance and scale, an SCv3020 can be sized for moderate workloads that demand low latency. The key items tested are:

- IOP capability
- Latency under load
- Consistent performance under varying load

1.2 Audience

This reference architecture is targeted at anyone who wishes to better understand the performance and scalability of the SCv3020 storage platform running the current generation of mixed-use solid-state drives. It is intended to show what the platform is capable of from a VDI workload perspective. The results will be different under other workloads. Performance under other workloads can be found on the Dell TechCenter page, SC Series Technical Documents.

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2 SCv3000 Series solution overview

2.1 Accelerate your workloads, automate your savings

The SCv30000 Series is a revolutionary upgrade to the popular SCv2000 Series, offering a full range of powerful SC Series features previously unavailable in this category.

The new SCv3000 Series array makes storage cost savings automatic with a modern architecture that optimizes the data center for economics while delivering transformational SSD, HDD, or hybrid performance. Highlights include:

- **Data Progression**: Achieve IOPS goals with the least-expensive mix of storage media, even as performance needs evolve.
- **Intelligent Compression:** Dramatically reduce the raw capacity required to store data.
- **RAID tiering:** Eliminate manual RAID provisioning, and increase efficiency and utilization.
- **Federation:** Simplify multi-array environments with quick and seamless data movement, plus proactive load balancing assistance using Live Migrate and Volume Advisor.
- **Replication** with other SC and PS series arrays.
- **Live Volume:** enables native business continuity /disaster recovery
- **Dell ProSupport™ services**: Reduce deployment costs with remote installation options that ensure the project is successful the first time.

2.2 All-new hardware platform

Designed as the next-generation successor to the popular SCv2000 Series arrays, the SCv3000 Series offers an impressive features set and delivers transformational HDD, hybrid, SSD performance for its targeted segment. With dual 6-core Intel® processors, 2x more memory, and a 12Gb SAS back end, the SCv3000 delivers:

- Up to 50% more IOPs and capacity (1)
- Up to 3x more bandwidth (1)
- 2x maximum snapshots

[1] Based on April 2017 internal Dell EMC testing, compared to previous-generation SCv2000. Actual performance will vary depending on application and configuration

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SCv3000 has two base array options – Both models feature a 3U "all-in-one" format, including dual controllers with 6-core Intel processors, 32GB memory (16GB per controller) and flexible 10GB iSCSI, 12GB SAS or 16GB FC network connections.

SCv3000
(16) 3.5" drive slots, 3U

SCv3020
(30) 2.5" drive slots, 3U

Three optional expansion enclosures – Customers can mix and match in any combination with either base unit, scaling up to 222 drives, or 1PB per array* – with even larger scale-out potential in federated multi-array systems. All array and expansion enclosure models support a variety of SSD, 15K, 10K and NLSAS drives, including FIPS-certified Self-Encrypting Drives (SEDs).

SCv300
(12) 3.5" drive slots, 2U

SCv320
(24) 2.5" drive slots, 2U

SCv360
(60) 3.5" drive slots, 4U

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3 Solution architecture

3.1 Environment

There are a large number of components required to drive an environment of this scale. They all need to work together to provide a stable and seamless solution for VDI to work correctly.

3.2 Software

The solution is built on layers of software and hardware. Each component provides a key piece of the puzzle.

3.2.1 Software components

The solution presented in this paper used the following software:

- VMware Horizon® 7.1
- VMware vSphere hypervisor 6.5
- VMware vSphere management
- Login VSI® (for simulating real-world VDI workloads)
- Microsoft Windows Server® 2016 and Windows 7

All software components were updated to the most currently available patch level for the tests.

3.2.2 VMware vSphere host

VMware vSphere is the top enterprise virtualization platform used for building VDI and cloud infrastructures. VMware vSphere includes three major layers: virtualization, management, and interface. The virtualization layer includes infrastructure and application services. The management layer is central for configuring, provisioning, and managing virtualized environments. The interface layer includes the vSphere client and the vSphere web client.

Throughout the solution, all VMware and Microsoft best practices and prerequisites for core services are adhered to (for example, NTP, DNS, and Microsoft Active Directory®). The vCenter servers used in the solution are VMware vCenter Server Appliances v6.5. All hosts were running vSphere 6.5.

3.2.3 VMware Horizon 7.1

The VDI management platform used was VMware Horizon 7.1 with linked clones. Horizon allows a number of different cloning options, as well as managing discrete desktops. It is designed to scale to large numbers of end-points in a single interface, and provide consistency and manageability in large environments.

Linked clones were chosen for their management and small footprint. This is a very commonly used configuration because of its efficiencies and ease of use.

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Horizon has several components that make up the product:

Connection Server: The Connection Server is the central hub for managing connections. Users connect using either the Horizon View client or a web browser. The Connection Server then connects the user to the proper virtual desktop session based on the assignments. Users can either be assigned a static machine (in this case, for persistence) or given a random machine in a non-persistent environment.

Composer: The Horizon View Composer server handles the tasks of provisioning virtual desktops to the proper pool using the correct base image. It also handles maintenance tasks, such as a desktop refresh or recompose. There were two Composer VMs, each registered to a connection server.

Horizon View agent: Installed on user devices, the Horizon View agent provides users with quick, secure, multi-protocol access to documents, applications, and desktops from any of the user's devices including smartphones, tablets, and PCs. VMware Horizon provides on-demand access to Windows, web, and Software as a Service (SaaS) applications.

Management console: The Horizon View management console is a web service application that can be run from any Windows server in the environment. The management servers used were configured using VMware vCenter™ 6.5 with a central Microsoft SQL Server® 2014 instance. There were two management servers configured, each controlling 1000 virtual machines.

3.2.3.1   Linked clones

All 2,000 virtual machines were created in less than an hour using parallel environments taking advantage of the all-flash array performance.

The virtual machines were created using the linked clone method in Horizon View. This provides efficient use of space and simplifies management. By using linked clones, a replica image is used for shared data resulting in a very small footprint. After cloning, the total space consumed is 2GB/VM in a persistent state before user login.

After the user profiles were created, the VMs each consumed approximately 3GB of space. This includes the user customizations, page file, and changes made to customize each VM to the assigned user. Each VM runs Microsoft Office 2010, Adobe® Reader®, and a mix of Login VSI™ applications

Virtual desktops are assigned to the same user every time with desktop persistence. All changes made by a user are retained for future sessions. The changes are stored in a delta VMDK stored with the VM.

All the desktops are in an automated desktop pool with dedicated user assignments. Those desktops are based on a master desktop template, which is selected when the pool is created. This ensures each user gets a dedicated machine they can customize.

Horizon View also supports creating non-persistent environments to streamline support and troubleshooting. These desktops automatically revert to the default configuration upon user logoff.

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3.2.4 Microsoft Windows 7

Each of the desktops was a Windows 7 Enterprise client. Windows 7 32-bit was chosen for this configuration. All patches were applied to the desktop image before the base replica was created.

Some Windows components were disabled to reduce resource requirements, in accordance with best practices. In each desktop, indexing was disabled, the frequency of Windows updates was limited, and pagefile and temporary files were redirected to a separate volume. All disk traffic was captured during the test runs.

3.2.5 Microsoft Windows Server 2016

For all Windows Server based functions, Windows Server 2016 was used, with all current patches. The VM hardware configuration varied based on the roles and is documented in the appendices.

3.3 Hardware

A fully functional VDI environment for 2,000 virtual machines requires a large amount of hardware with significant compute and memory resources. The act of virtualizing does realize great efficiencies but cannot eliminate the requirement to process data. The act of virtualizing collapses the environment into dense clusters of resources.

3.3.1 Hardware components

The hardware used to host the environment consisted of the following:

- Dell PowerEdge™ blade servers for VDI workload
- Dell PowerEdge M1000e blade enclosures
- Dell EMC Networking MXL Ethernet blade switches
- Dell EMC Networking S5000 top-of-rack (ToR) Ethernet switch
- Brocade® M5424 Fibre Channel (FC) blade modules
- Brocade 6505 FC ToR switches
- Dell EMC SCv3020 storage array

There are many sizing tools to gauge the processor and memory requirements for virtual machines. They are outside the scope of this document. See the VMware community sizing guidelines and VMWare Windows 7 sizing guidelines. In this scenario 125 VMs were created per LUN. The sizing guidelines state 20+ IOPS per user. By achieving 25 IOPS per user the SCv3020 exceeds the performance requirements of heavy workloads.

3.3.2 Storage

The storage used was an SCv3020 array with mixed-use solid-state drives. The mixed-use drives provide excellent performance with a very attractive price point. They are also low-power devices relative to spinning drives and generate far less heat. The storage density is also very good.

Technical highlights of the SCv3020 include:

Array configurations: All-flash, hybrid, or HDD arrays.

Auto-tiering method: Policy-based migration based on real-time data usage, customizable 512KB-4MB page size.

Auto-tiering structure: Up to three primary (media-based) tiers total, with up to two SSD tiers (write- and read-intensive SSDs).

RAID support: RAID 0, 1, 5, 6, RAID 10, and RAID 10 DM (dual mirror); any combination of RAID levels can exist on a single array.

RAID tiering: Auto-provisions and dynamically restripes multiple RAID levels on the same tier; no need to pre-allocate RAID groups.

Thin provisioning: Active by default on all volumes, operates at full performance across all features.

Thin snapshots: Records changes only; snapshots auto-migrate to lower-cost storage.

Intelligent deduplication and compression: Selectable option per volume on SSD and/or HDD tiers. Compression-only option also available.

Standard replication: Synchronous/asynchronous through FC or iSCSI.

Federated multi-array systems: Live Migrate (included in base product) enables host-transparent data movement among arrays. Volume Advisor continually monitors federation to suggest optimal data placement based on customizable capacity or performance load balancing policies. Dell Storage Manager (DSM) provides data-center-level viewpoint and control.

Business continuity: Live Volume auto-failover, auto-repair, VMware Metro Stretch Cluster support, and Microsoft Azure® Site Recovery.

The tests were conducted using Storage Center OS (SCOS) 7.2 with system write cache disabled. There are considerable improvements to performance in SCOS 7.2 over previous versions. These gains will be available to all platforms supporting this release of firmware.

The drives used were 1.92TB drives, providing usable space of 1.75TB per drive. The system contained 20 drives with 2 dedicated spares. This provided 35TB of raw space. In this case, a smaller drive could be used as long as it provides the same performance per drive. This system is sized for capacity growth and to allow snapshots to be kept. The target for this test is performance not capacity, and final requirements will dictate the drive capacity used.

All storage hardware was configured to Dell best practices with vSphere. For more information, see the document, *Dell EMC SC Series Best Practices with VMware vSphere 5.x–6.x*.

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3.3.3 Hosting environment

The environment running the VMs makes up the majority of the hardware required. The power, rack space, cooling, and management requirements are much larger than the storage components. This is normal based on the processing power and memory requirements of 2000 virtual machines.

Table 1   Host configuration

Component	Description
Host	PowerEdge M620, two 8-core Intel® Xeon® Processor E5-2680, 320GB RAM
Operating system	vSphere 6.5
Fibre Channel	QLogic® QME2572 HBA, Brocade M5424 chassis-based switch
Network	Dell EMC Networking MXL 10Gb dual-port Ethernet module
Virtual desktop configuration	2 vCPUs, 2GB RAM, VMXNet3, 30GB volume

Table 2   Virtual machine configurations

Component	Description
Infrastructure VMs	4 vCPUs, 8GB RAM, VMXNet3 vNIC, Login VSI 4.1.25 agent
Operating system	Windows Server 2016
vNIC	VMXNet3
Applications	Microsoft Active Directory®, DNS, DHCP, vCenter Servers, Horizon Connection and Composer servers, Microsoft SQL Server®, DSM

Table 3   Infrastructure servers

Component	Description
Operating System	Windows Server 2016
vNIC	VMXNet3
Applications	Active Directory, DNS, DHCP, vCenter Servers, Horizon Connection and Composer servers, SQL Server, DSM

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Table 4   Storage

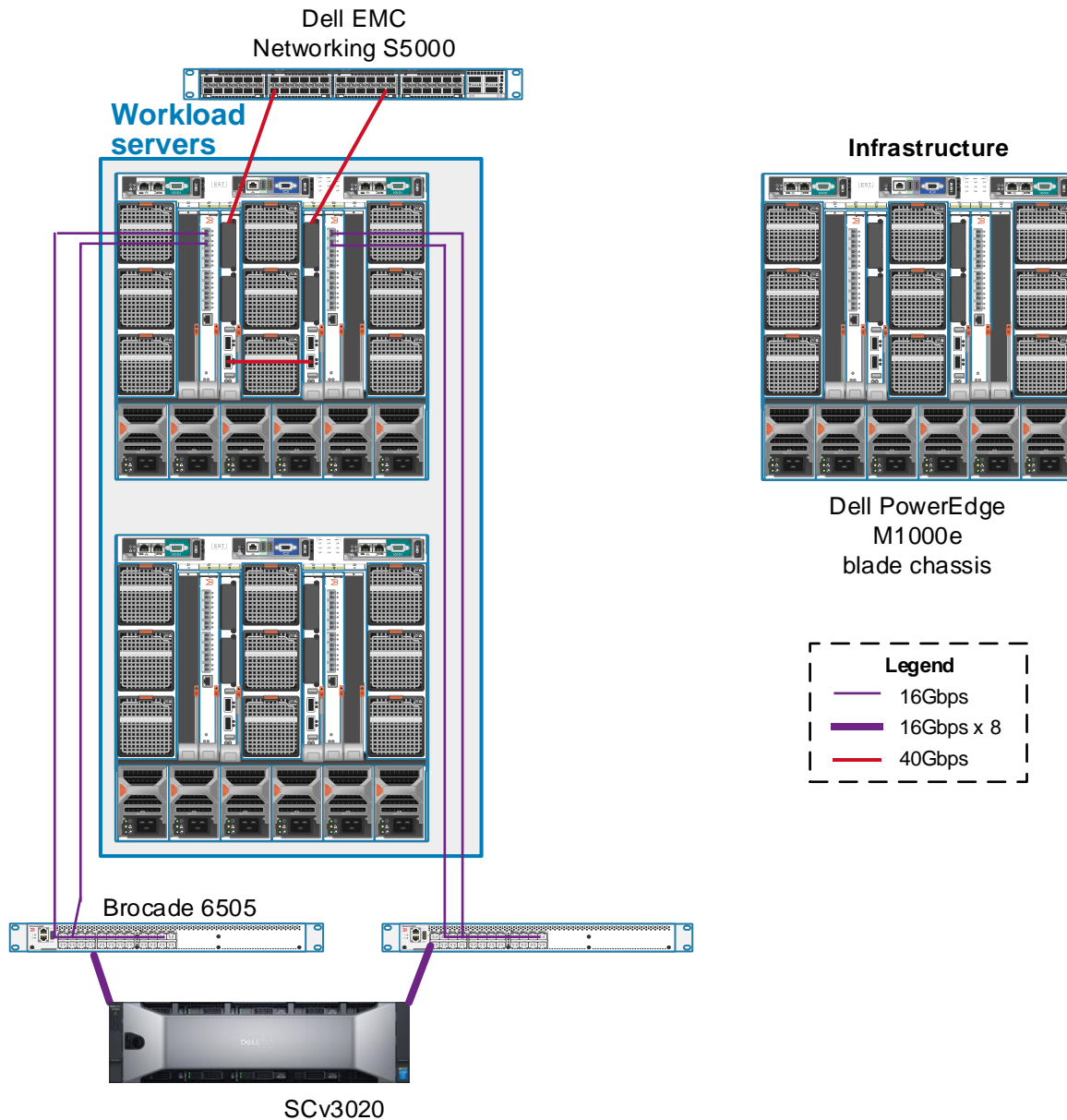| Component	Description
SCv3020	Dual storage controllers
16Gb 8-port Fibre Channel	QLogic 16Gb 4-port Fibre Channel adapters, 1 per controller head
SCOS 7.2	Storage firmware
Drives	20 x 1.92TB: 18 active, 2 spares

Figure 1   Hosting environment

A dedicated server was used for the Login VSI control and file-sharing server. This is due to the **very** high I/O requirements of the centralized share. At times, the throughput exceeded 10 Gb/sec from the file share. The Login VSI share server was a PowerEdge M620, with 144GB of RAM and 2 x 10Gbps Intel® Ethernet modules.

3.3.4 Networking

The network architecture consists of 10Gbps dual-port network adapters in each server trunked to a 10/40Gbps Dell EMC Networking MXL dual-switch stack in each blade chassis. Each MXL stack pair is cross-connected with a 40Gbps connection and trunked with two 40Gbps QSFP+ connections to a ToR Dell EMC Networking S5000 switch.

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4 Testing

4.1 Test objectives

The series of tests run for this reference architecture are designed to capture the performance of the SCV3020 controllers. The tests were scaled to run within the limits of the SCV3020 controllers and highlight their performance.

4.2 Test tools

4.2.1 Load generation

The load-generation tools used were created by Login VSI consultants. These are End User Computing standard tools for consistent load generation and allow Dell EMC to compare performance results across platforms and the industry by leveraging a standardized workload.

4.2.2 Load monitoring

Dell Storage Manager (DSM) was used to chart and report on all aspects of the underlying storage. DSM can share real-time I/O, report on historical performance or capacity utilization, as well as provide a single pane of glass for multiple storage arrays.

DSM is also the control plane for replication on SC Series arrays.

4.3 Test phases

4.3.1 Boot phase

Figure 2 shows the storage load as the virtual machines are turned on as quickly as possible. In order to achieve faster boot times, PowerCLI was used to connect to each of the hosts and power on virtual machines as quickly as possible. This may be required to boot an environment after a complete outage, whether controlled or unplanned. The figure shows the rapid boot times available on Dell EMC all-flash storage.
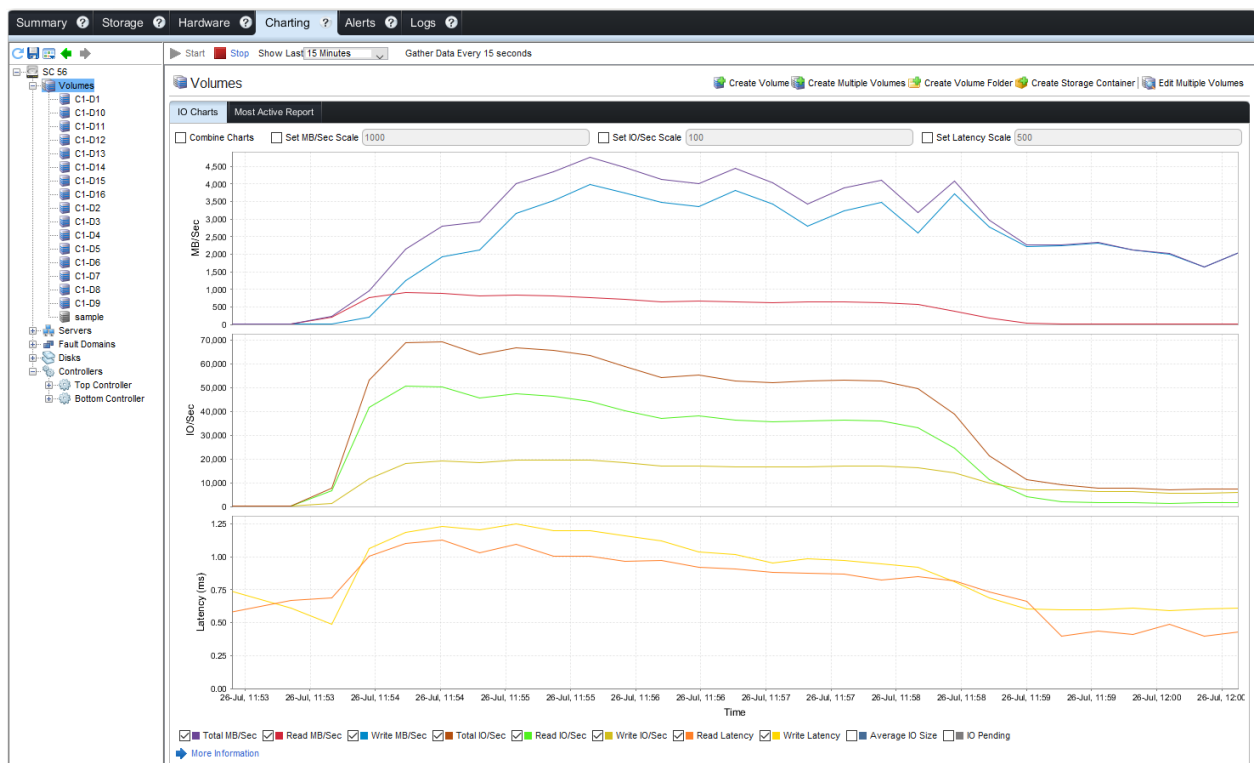

Figure 2   Boot storm

As the chart shows, almost 75,000 IOPS at 4.8GB/Sec were generated during the time it took to boot all 2,000 VMs. The time required to boot all VMs to the login screen was less than 6 minutes. This workload is uncommon because most customers very rarely reboot an entire environment.

4.3.2   Login phase

This test is a more important scenario because it demonstrates the expected performance during mass user logins, a workload which is a daily occurrence. Each morning, users log in in waves, generating large amounts of data. The chart transitions directly into the next phase which is steady state. Figure 3 shows the login phase.
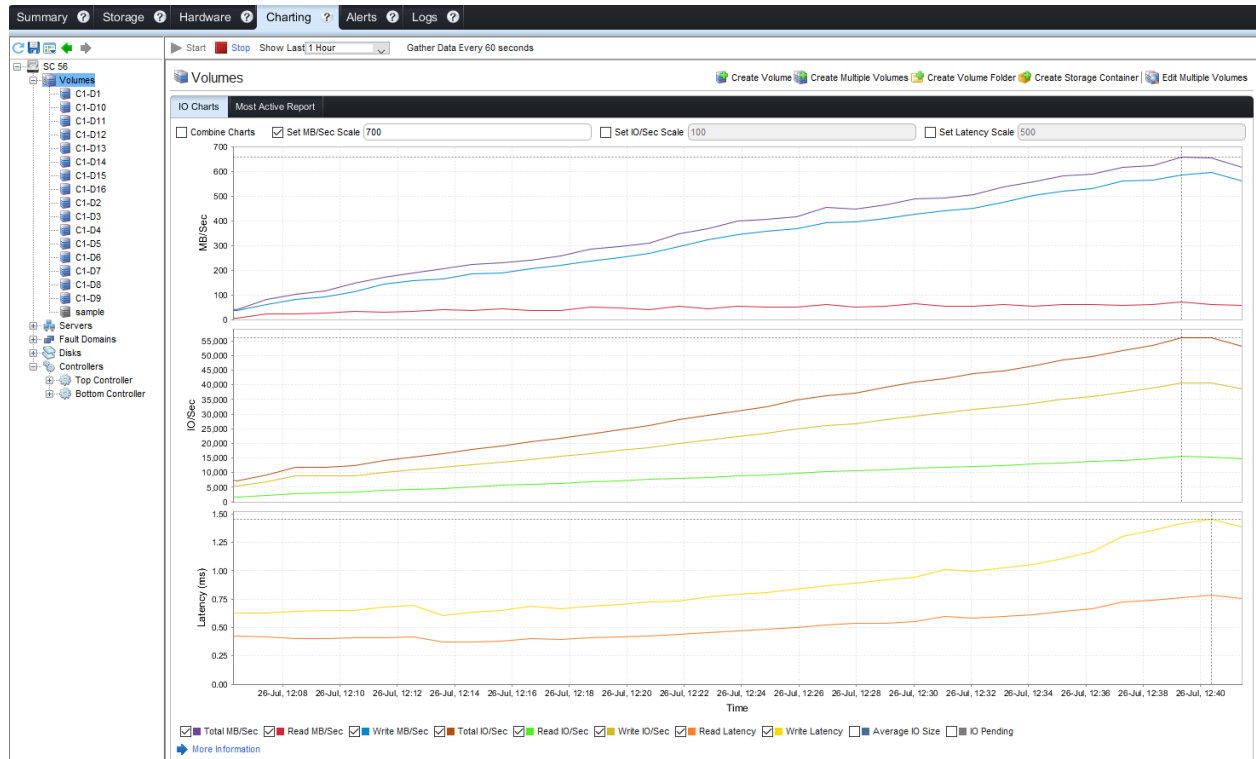

Figure 3   Login phase

This chart shows the steady increase in load as more and more users log in to the system. As seen in the chart, the SCV3020 provides excellent performance with predictable latency as the load increases.

Figure 4 shows the time to login and the number of sessions successfully launched.
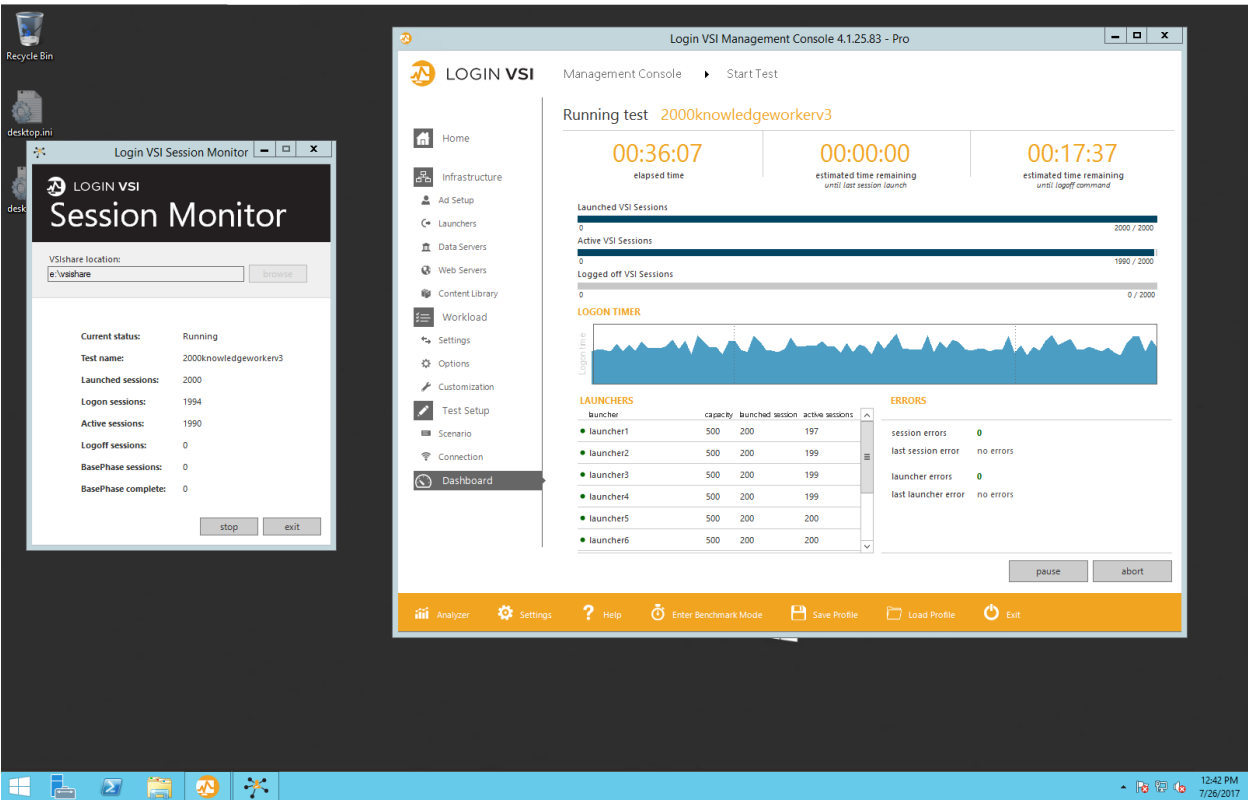

Figure 4   Login time and sessions launched

The logins generated 55,000 IOPS, with latency just under 1.5ms. This level of performance allows an excellent end-user experience, provided the compute and memory are properly sized. A storage latency this low ensures the storage will not be the gating factor in the user experience.

4.3.3 Steady-state workload

The steady-state workload used for these tests was targeted for 20 IOPS per user, to simulate a heavier-than-normal workload per user.
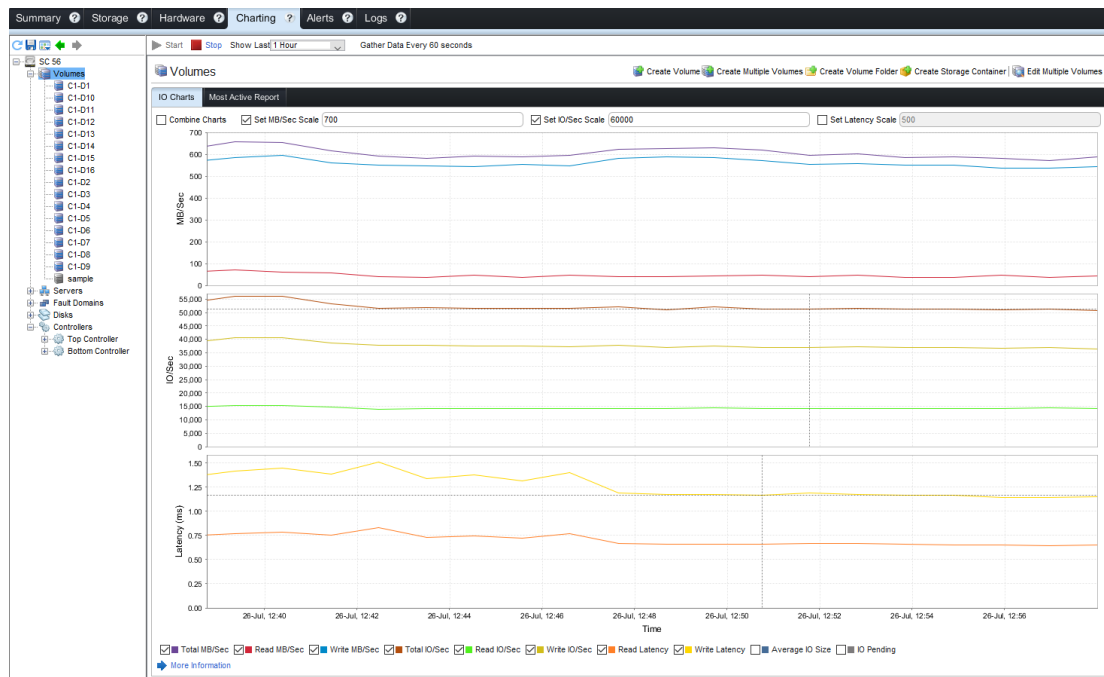

Figure 5   Steady-state workload

As Figure 5 shows The SCV3020 handled over 25 IOPS per user while maintaining just 1.25ms of write latency. Being able to sustain such a low latency at over 25 IOPS per user ensures the SCV3020 can provide fast, consistent performance for VDI workloads.

4.4 Test results

Figure 8 shows the output from the Login VSI test tool, charting the user login and application response times. As indicated in the chart, the threshold is 2,674 ms, with an average latency provided of just 1,910 ms. This solution delivered a latency of 72 percent of the threshold.
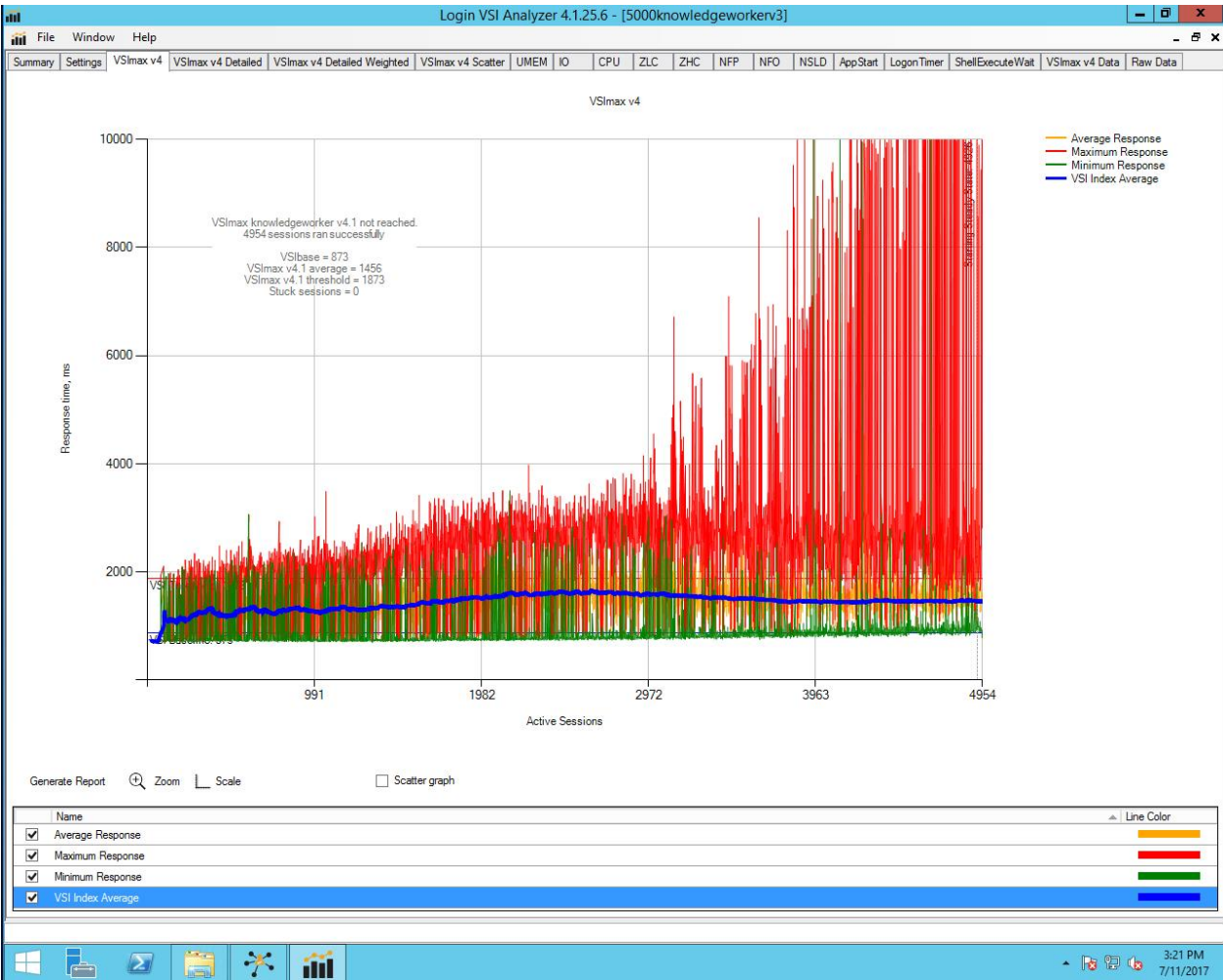

Figure 6 Login VSI results

5 Conclusion

The true test of the workload is how well the system responds to user input. Storage is just one gear in the machine enabling users to run their workloads. The testing described in this document shows how well the storage performs under a full workload.

The data show the SCV3020 storage array to be an excellent platform for 2,000 heavy power users. It provides good performance and scalability, with up to 1PB of usable, configurable storage in a reliable and stable platform.

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A Environment

A.1 Horizon View

Table 5   Horizon View configuration

Component	Description
Horizon View	7.1
Role	Virtual machine assignment, management, web interface, connection broker
Servers	Four 4-core servers, 12GB RAM
Cabling	10Gbps VMXNet3

A.2 VMware hosts

Table 6   VMware host hardware configuration

Component	Description
VMware host	6.5
Role	End-user compute node
Hardware	Two 8-core processors, 320GB RAM
Storage	200GB SSD for boot/log

A.3 VMware vCenter

Table 7   vCenter server configuration

Component	Description
VMware vCenter appliance	6.5, two virtual vCenter appliances for end-user VMs, one appliance for infrastructure
Role	Management of all hosts, DRM load balancing, host monitoring

A.4 Login VSI

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Table 8   Login VSI configuration

Component	Description
Login VSI	4.1.25
Role	Workload generation and application performance reporting

A.5   Windows desktops

Table 9   Virtual desktop configuration

Component	Description
Client desktops	Windows 7
Memory	2GB
Processor	2 vCPUs
Applications	Office 2010, Adobe Reader, WinZip®, Freemind, Doro PDF Writer

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B Technical support and resources

Dell.com/support is focused on meeting customer needs with proven services and support.

Dell TechCenter is an online technical community where IT professionals have access to numerous resources for Dell software, hardware, and services.

Storage Solutions Technical Documents on Dell TechCenter provide expertise that helps to ensure customer success on Dell EMC Storage platforms.

B.1 VMware support

For VMware support, see the following resources:

- VMware.com
- Education and training
- Online documentation
- VMware communities

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