

BOOSTING VIRTUALIZATION PERFORMANCE WITH INTEL SSD DC P3600 SERIES NVME SSDS ON THE DELL EMC POWEREDGE R630

IMPROVE VIRTUALIZATION PERFORMANCE

with the Dell EMC PowerEdge™ R630 and Intel® SSD DC P3600 Series NVMe SSDs powered by the Intel Xeon® processor E5 v3 family

59.9% greater throughput
in a mixed virtualization workload
and 32 more VMs vs. SATA SSDs



with a VMware® VMmark® score of 14.42@11 tiles

In virtualized environments, virtual machines (VMs) often share underlying storage resources. While this is necessary to reap the benefits of consolidation, it has the effect of making input/output (I/O) patterns unpredictable when the hypervisor processes the storage-related activity of different simultaneous workloads, resulting in the I/O blender effect. The I/O blender effect can further stress the storage subsystem and cause a bottleneck on storage, hurting the performance of your diverse workloads.

One way to overcome the added I/O demands of running diverse virtualized workloads on shared storage while avoiding datacenter sprawl is to upgrade the drives in your configuration. In hands-on tests at Principled Technologies, we found that replacing SATA SSDs with new Intel SSD DC P3600 Series NVMe SSDs in a Dell EMC PowerEdge R630 environment running VMware Virtual SAN could boost storage throughput in a mixed virtualization workload by as much as 59.9 percent while supporting four more tiles, or 32 more VMs. This upgrade can enable you to continue to expand your virtualized application workloads, while giving your users a better experience on multiple applications through increased throughput, which means that business can run more smoothly.



BETTER STORAGE, BETTER PERFORMANCE

Intel NVMe SSDs are designed to deliver increased input/output per second (IOPS) compared to storage standards such as SATA SSDs, which are themselves a step forward from traditional HDDs. When used as the underlying hardware for VMware Virtual SAN storage in three Intel Xeon processor E5-2600 v3 family-based Dell EMC PowerEdge R630 servers, we found that Intel NVMe SSDs did just that.

To test the performance of multiple virtualized workloads in this environment, we used the industry-standard VMware VMmark 2.5.2 benchmark. VMmark incorporates a variety of workloads including vMotion® and Storage vMotion® and executes diverse workloads on a collection of virtual machines. VMmark expresses scores in terms of tiles; a tile consists of eight VMs that include database servers, Web servers, mail servers, and standby servers.

For more about the components we tested, see [Appendix A](#). To learn more about our system configuration, see [Appendix B](#). See [Appendix C](#) for our test methodology and [Appendix D](#) for detailed benchmark results.

WHAT WE FOUND

We found that using Intel NVMe SSDs instead of SATA SSDs increased performance by 59.9 percent (see Figure 1). For datacenter administrators, this performance boost is a real boon. If you can get more performance out of your servers and virtual SAN, you avoid having to add more to your sprawling infrastructure. This performance increase can have a positive effect on end-users, too. With higher-performing storage, users don't have to wait as long for operations to complete.

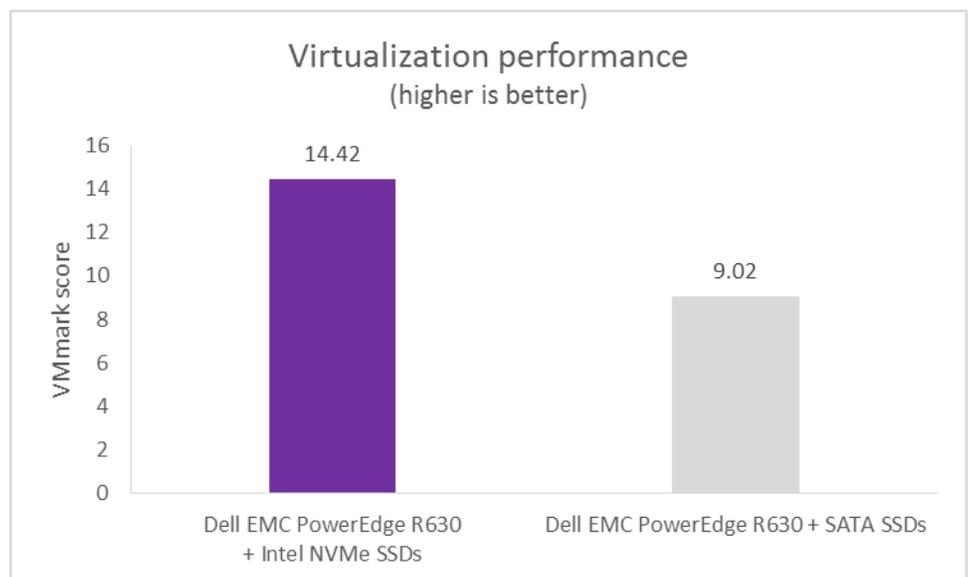


Figure 1: The Dell EMC PowerEdge R630 environment with Intel NVMe SSDs outperformed the same server with SATA SSDs on the VMmark benchmark while supporting more tiles.

As Figure 2 shows, the Dell EMC PowerEdge R630 environment with Intel NVMe SSDs delivered that improved performance while also supporting four more tiles—and therefore 32 more VMs--than the SATA SSD configuration. This is another way to look at the improved performance you can get by upgrading your PowerEdge R630 environment to Intel NVMe SSDs.

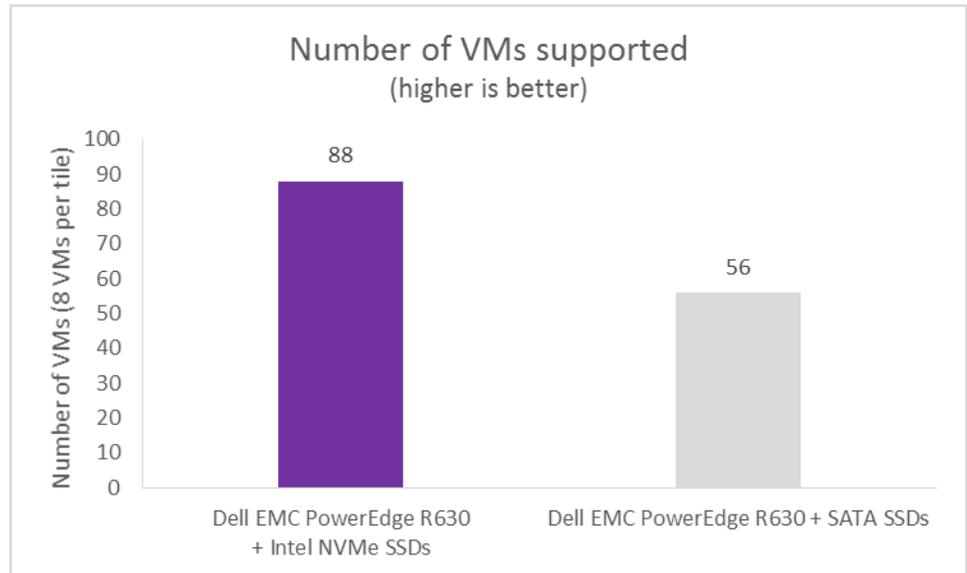


Figure 2: VMs the two configurations supported during our testing (each tile has eight VMs).

CONCLUSION

When it comes time to make your server purchase or if you're looking for an easy way to boost performance of existing infrastructure, consider upgrading your server's internal storage. As our hands-on tests with a Dell EMC PowerEdge R630 environment running VMware Virtual SAN proved, Intel SSD DC P3600 Series NVMe SSDs could increase virtualized mixed-workload performance by as much as 59.9 percent compared to SATA SSDs while allowing you to run a large additional number of VMs. When you improve performance for your virtualized workloads, your employees and customers will benefit. By increasing performance with Intel NVMe SSDs on your Dell EMC PowerEdge R630 servers, you can potentially slash wait times and do more work on your servers without having to expand your infrastructure with additional storage arrays, which can translate to happier users and a more efficient infrastructure.

APPENDIX A – ABOUT THE COMPONENTS

About the Dell EMC PowerEdge R630

Fitting into just 1U of rack space, the Dell EMC PowerEdge R630 features two Intel Xeon processors E5-2670 v3 to deliver high compute performance. Dell EMC designed the PowerEdge R630 with cloud applications, virtualization environments, and high performance computing (HPC) infrastructures in mind. The PowerEdge R630 has 24 DIMM slots to support up to 1.5 TB of memory, supports an optional internal GPU processing accelerator, and can support up to four optional NVMe Express Flash PCIe SSDs to reduce storage bottlenecks.

With redundant power supply units, hot-swappable hardware, and Dual SD card for Failsafe Hypervisors, the Dell EMC PowerEdge R630 supports hardware high availability. The PowerEdge R630 comes standard with iDRAC8 with Lifecycle Controller and Dell EMC OpenManage, which all work to streamline management.

Learn more at www.dell.com/us/business/p/poweredge-r630/pd.

About the Intel Xeon processor E5-2600 v3 product family

According to Intel, the Intel Xeon processor E5-2600 v3 product family “helps IT address the growing demands placed on infrastructure, from supporting business growth to enabling new services faster, delivering new applications in the enterprise, technical computing, communications, storage, and cloud.” It also delivers benefits in performance, power efficiency, virtualization, and security.

The E5-2600 v3 product family has up to 50 percent more cores and cache than processors from the previous generation. Other features include the following:

- Intel Advanced Vector Extensions 2 (AVX2)
- Intel Quick Path Interconnect link
- Up to 18 cores and 36 threads per socket
- Up to 45MB of last level cache
- Next-generation DDR4 memory support
- Intel Integrated I/O providing up to 80 PCIe lanes per two-socket server
- Intel AES-NI data encryption/decryption

The Intel Xeon processor E5-2600 v3 product family also uses Intel Intelligent Power technology and Per-core P states to maximize energy efficiency. Learn more at <http://ark.intel.com/products/family/78583/Intel-Xeon-Processor-E5-v3-Family#@All>.

About Intel SSD DC P3600 Series NVMe SSDs

Intel NVMe SSDs are designed to take advantage of non-volatile memory express storage interface standards to deliver higher throughput than SATA and SAS SSDs as well as traditional HDDs.

The Intel SSD DC P3600 Series offers NVMe drives in capacities from 400 GB to 2.0 TB and come in two form factors: 2.5-inch and HHHL AIC. To learn more about the Intel SSD DC P3600 Series, visit www.intel.com/content/www/us/en/solid-state-drives/ssd-dc-p3600-spec.html.

About VMmark 2.5.2

We selected VMmark 2.5.2 to measure the performance of the NVMe Express Flash PCIe SSDs and SATA SSDs. To compare platforms for virtualization, users need meaningful and accurate metrics. Benchmarks developed to measure performance in non-virtualized environments work by pushing one or more of the underlying hardware

resources to saturation. They don't help you understand how virtual environments supporting multiple simultaneous workloads can scale.

Some multi-workload server consolidation benchmarks, such as VMware VMmark 1.1, measure single-host performance in virtualized environments. However, typical server usage is evolving as technological advances enable easier virtualization of bursty and heavy workloads, dynamic virtual machine relocation, dynamic datastore relocation, and the automation of many provisioning and administrative tasks across large-scale multi-host environments. Now, much of the stress on CPU, network, disk, and memory subsystems is generated by the underlying infrastructure operations. Application performance also depends on effectively balancing load across multiple hosts. To be useful in this environment, a benchmark needs to look at both user-centric application performance and overall platform performance.

VMware VMmark 2.5.2, which has become an industry standard, meets these criteria. In addition to using this unique benchmark approach, VMware maintains very strict standards for execution and publication. Learn more about VMmark at www.vmware.com/products/vmmark.html.

About VMware Virtual SAN 6.2

VMware Virtual SAN 6.2 is a software-defined shared storage solution that allows policy-based provisioning of direct-attached storage on server nodes. It automates many manual storage tasks such as disk management, storage optimization, and fault tolerance. Virtual SAN offers flexibility that lets companies grow their storage environments as they need to, letting admins increase storage capacity to new or existing hosts on the fly. It uses a flash pool as a read/write storage cache, improving the performance of direct-attached disks.

For more information about VMware Virtual SAN, visit www.vmware.com/products/virtual-san.html.

APPENDIX B – SYSTEM CONFIGURATION INFORMATION

Figure 3 provides detailed configuration information for the test systems. We used three Dell EMC PowerEdge R630 servers in our testbed, as a VMware Virtual SAN configuration requires a minimum of three servers. We configured all three servers identically.

System	Dell EMC PowerEdge R630
Power supplies	
Total number	2
Vendor and model number	Dell EMC 0G6W6KX02
Wattage of each (W)	750
Cooling fans	
Total number	7
Vendor and model number	Nidec® R40W12BS1NB8-07A02
Volts	12
General	
Number of processor packages	2
Number of cores per processor	12
Number of hardware threads per core	2
System power management policy	Performance
CPU	
Vendor	Intel
Name	Xeon
Model number	E5-2670 v3
Socket type	FCLGA2011-3
Core frequency (GHz)	2.3
Bus frequency	9.6 GT/s
L1 cache	32KB + 32KB (per core)
L2 cache	256KB (per core)
L3 cache	30 MB
Platform	
Vendor and model number	Dell EMC PowerEdge R630
BIOS name and version	2.1.6
BIOS settings	Performance
Memory module(s)	
Total RAM in system (GB)	256
Vendor and model number	Samsung M386A4G40DM0-CPB
Type	PC4-2133P
Speed (MHz)	2,133
Speed running in the system (MHz)	2,133
Timing/Latency (tCL-tRCD-tRP-tRASmin)	15-15-15-36
Size (GB)	32
Number of RAM module(s)	8
Chip organization	Double-Sided
Rank	Dual

System	Dell EMC PowerEdge R630
Operating system	
Name	VMware ESXi 6.0 Update 2
Build number	3825889
RAID controller	
Vendor and model number	Dell EMC PERC H730 Mini on host 1, Dell EMC PERC H730P Mini on hosts 2 and 3
Firmware version	25.4.0.0017
Cache size (MB)	1,024
Solid-state drives 1	
Vendor and model number	Intel DC S3510 SSDSC2BB800G6R
Number of drives	4
Size (GB)	800
Type	SATA SSD
Solid-state drives 2	
Vendor and model number	Intel DC P3600 SSDPE2ME020T4
Number of drives	4
Size (GB)	2,000
Type	NVMe PCIe SSD
Hard drives	
Vendor and model number	Seagate Constellation.2 ST9250610NS
Number of drives	2
Size (GB)	250
RPM	7,200
Type	HDD
Ethernet adapter 1	
Vendor and model number	Intel 1Gbps dual-port I350 adapter
Type	Internal
Ethernet adapter 2	
Vendor and model number	Intel 82599EB 10-Gigabit SFI/SFP+ adapter
Type	Internal
Ethernet adapter 3	
Vendor and model number	Intel 82599EB 10-Gigabit SFP+
Type	PCIe

Figure 3: Configuration information for our test systems.

APPENDIX C – HOW WE TESTED

To test the VMmark performance of three Dell EMC PowerEdge R630 servers with and without Intel NVMe SSDs, we downloaded the VMmark 2.5.2 Virtualization Platform Benchmark from www.vmware.com/products/vmmark. We followed the VMmark_Benchmarking_Guide_2.5.2b.pdf documentation for the VMmark setup instructions.

The three Dell EMC PowerEdge R630 servers were configured in an ESX cluster as required by VMmark run rules. We configured each of the three Dell EMC R630 servers with four SSDs per system and then used VMware vSAN 6.2 to configure a storage volume across the 12 drives. We stored all VMmark tiles on a 12-disk vSAN volume.

We used five Dell EMC PowerEdge C8220 servers for the client test bed. One C8220 was used for the non-virtualized VMmark controller. Three of the C8220 servers ran up to four virtual clients each, running Windows Server 2008 R2 inside each one. All virtual clients had a single 10GbE network connection. We used seven of the virtual clients on the SATA SSD configuration and 11 of the virtual clients on the NVMe SSD configuration. One of the C8220 servers ran vCenter Server with a single 10GbE connection.

VMmark does storage vMotion during the benchmark run, which requires two datastore volumes. We needed another storage solution for this part of the test because you can only configure VMware vSAN into a single volume. We used a Red Hat Enterprise Linux 7.2 host to act as an iSCSI target for the second datastore volume. We used Linux-IO Target (LIO) for this.

Once the base OS was installed, we used the following commands to configure a Linux-IO Target for use with VMmark testing.

```
yum -y install targetcli
mkdir /iscsi_disks
systemctl enable target
targetcli
backstores/fileio/ create disk01 /iscsi_disks/disk01.img 10G
iscsi/ create iqn.2014-07.world.srv:storage.target00
cd iqn.2014-07.world.srv:storage.target00/tpg1
luns/ create /backstores/fileio/disk01
acls/ create iqn.2014-07.world.srv:www.srv.world
exit
firewall-cmd --permanent --add-port=3260/tcp
firewall-cmd --reload
```

APPENDIX D – VMMARK 2.5.2 DETAILED RESULTS

The following table presents results for our SATA SSD configuration.

VMware® VMmark® V2.5.2 Results																
Vendor and Hardware Platform: Dell PowerEdge R630 Virtualization Platform: VMware ESXi 6.0 Update 2 Build 3825889 VMware vCenter Server : VMware vCenter Server 6.0 Update 2 Build 3634793												VMmark V2.5.2 Score = 9.02 @ 7 Tiles				
Number of Hosts: 3				Uniform Hosts [yes/no]: no				Total sockets/cores/threads in test: 6/72/144								
Tested By: Principled Technologies, Inc.								Test Date: [08-03-2016]								
Performance Section Performance				Configuration Section Configuration				Notes Section Notes for Workload								

Performance

	mailserver			olio			dvdstoreA			dvdstoreB			dvdstoreC			
TILE_0	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	GM
p0	330.57	1.00	318.25	4781.98	1.03	53.43	3454.78	1.57	118.99	2607.62	1.72	131.92	1865.03	1.76	141.85	1.37
p1	329.40	1.00	261.00	4770.07	1.03	55.00	4320.23	1.96	55.17	3085.68	2.03	61.36	2310.70	2.18	64.49	1.55
p2	327.32	0.99	234.22	4796.85	1.03	57.12	4317.20	1.96	55.64	3073.88	2.02	62.22	2188.25	2.07	66.17	1.53
TILE_1	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	GM
p0	328.75	1.00	337.20	4791.07	1.03	48.25	2793.62	1.27	146.74	2004.75	1.32	161.83	1516.00	1.43	168.28	1.20
p1	332.48	1.01	262.00	4793.00	1.03	51.95	4350.43	1.98	54.22	3124.35	2.06	59.90	2224.95	2.10	64.08	1.55
p2	328.95	1.00	232.00	4797.18	1.03	54.69	4387.00	1.99	53.53	3249.00	2.14	59.16	2332.55	2.20	63.84	1.57
TILE_2	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	GM
p0	324.85	0.98	236.97	4786.18	1.03	50.02	4010.68	1.82	73.59	2936.28	1.93	82.76	2118.68	2.00	86.24	1.48
p1	323.57	0.98	195.00	4783.02	1.03	51.01	4619.00	2.10	45.85	3323.20	2.19	50.79	2388.53	2.26	53.80	1.60
p2	327.18	0.99	176.50	4806.15	1.04	52.84	4547.90	2.07	48.02	3516.03	2.32	52.29	2561.82	2.42	55.69	1.64
TILE_3	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	GM
p0	324.00	0.98	377.73	4786.90	1.03	49.00	3491.72	1.59	108.10	2560.45	1.69	119.22	1856.45	1.75	124.80	1.37
p1	327.95	0.99	297.73	4795.45	1.03	52.12	4335.48	1.97	54.82	3228.03	2.13	59.80	2333.12	2.21	63.37	1.57
p2	325.62	0.99	257.50	4783.52	1.03	53.62	4329.82	1.97	54.99	3202.38	2.11	61.25	2430.97	2.30	63.78	1.58
TILE_4	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	GM
p0	325.25	0.98	351.07	4791.15	1.03	50.98	3085.85	1.40	134.05	2201.57	1.45	149.48	1574.12	1.49	157.05	1.25
p1	326.20	0.99	275.25	4797.85	1.03	51.16	4316.77	1.96	55.25	3208.38	2.11	60.82	2423.12	2.29	64.17	1.58

p2	323.85	0.98	236.82	4789.25	1.03	53.55	4401.10	2.00	52.56	3160.12	2.08	58.31	2244.95	2.12	62.67	1.55
TILE_5	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	GM
p0	329.80	1.00	376.85	4763.43	1.03	48.37	3497.85	1.59	112.97	2654.28	1.75	124.29	1928.28	1.82	130.32	1.39
p1	324.45	0.98	283.00	4796.70	1.03	51.87	4500.68	2.05	49.45	3234.80	2.13	54.84	2406.95	2.27	58.64	1.59
p2	327.85	0.99	238.00	4783.40	1.03	52.22	4486.95	2.04	50.11	3311.32	2.18	56.16	2400.25	2.27	58.95	1.60
TILE_6	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	GM
p0	330.40	1.00	282.23	4767.10	1.03	49.33	3928.90	1.79	76.05	2917.85	1.92	82.58	2175.20	2.06	88.08	1.49
p1	327.02	0.99	226.43	4784.95	1.03	52.01	4415.40	2.01	52.20	3152.30	2.08	58.34	2258.60	2.13	61.52	1.55
p2	326.43	0.99	200.65	4772.20	1.03	53.14	4362.90	1.98	53.86	3230.32	2.13	59.82	2316.47	2.19	64.43	1.57

p0_score:	9.55
p1_score:	10.98
p2_score:	11.03

Infrastructure_Operations_Scores:	vmotion	svmotion	deploy
Completed_Ops_PerHour	18.50	10.00	5.00
Avg_Seconds_To_Complete	14.08	60.76	346.79
Failures	0.00	0.00	0.00
Ratio	1.16	1.11	1.25
Number_Of_Threads	1	1	1

Summary	Run_Is_Compliant	Turbo_Setting:0
	Number_Of_Compliance_Issues(0)*	Median_Phase(p1)
Unreviewed_VMmark2_Applications_Score	10.98	
Unreviewed_VMmark2_Infrastructure_Score	1.17	
Unreviewed_VMmark2_Score	9.02	

Configuration

Virtualization Software	
Hypervisor Vendor, Product, Version, and Build / Availability Date (MM-DD- YYYY)	VMware ESXi, 6.0 Update 2, Build 3825889 / 05-12-2016
Datacenter Management Software Vendor, Product, Version, and Build /	VMware vCenter Server, 6.0 Update 2, Build 3634793 / 03-16-2016

Availability Date (MM-DD-YYYY)	
Supplemental Software	None
Servers	
Quantity	3
Server Manufacturer and Model	Dell PowerEdge R630
Processor Vendor and Model	Intel Xeon E5-2670V3
Processor Speed (GHz)	2.30
Total Sockets/Total Cores/Total Threads	2 Sockets / 24 Cores / 48 Threads
Primary Cache	32KB I + 32KB D on chip per core
Secondary Cache	256KB I+D on chip per core
Other Cache	30MB I+D on chip per chip
BIOS Version	2.1.6
Memory Size (in GB, Number of DIMMs)	256GB, 8
Memory Type and Speed	32GB DIMMs 2Rx4 DDR4-2133MHz Registered ECC
Disk Subsystem Type	vSAN
Number of Disk Controllers	1
Disk Controller Vendors and Models	Dell PERC H730 Mini on SUT 1 Dell PERC H730P Mini on SUT 2 and 3
Number of Host Bus Adapters	0
Host Bus Adapter Vendors and Models	None
Number of Network Controllers	4
Network Controller Vendors and Models	1 x Intel 1Gbps dual port I350 adapter (embedded), 1 x Intel 82599EB 10-Gigabit SFI/SFP+ adapter (embedded) 2 x Intel 82599EB 10-Gigabit SFP+

Other Hardware	None
Other Software	VMware ESXi 6.0 driver package version 6.903.85.00 for Dell PERC H730/P Mini (VMW-ESX-6.0.0-Isi_mr3-6.903.85.00_MR-3818071.zip) VMware ESXi 5.5 driver package version 1.0e.2.0 for Intel NVMe drives (VMW-ESX-5.5.0-intel-nvme-1.0e.2.0-3132116.zip)
Hardware Availability Date (MM-DD-YYYY)	03-01-2016
Software Availability Date (MM-DD-YYYY)	05-12-2016
Network	
Network Switch Vendors and Models	Dell Force10 S4810
Network Speed	10Gbps
Storage	
Array Vendors, Models, and Firmware Versions	VMware Virtual SAN Details in section Storage Notes
Fibre Channel Switch Vendors and Models	None
Disk Space Used	4.26TB
Array Cache Size	Details in section Storage Notes
Total Number of Physical Disks Used	18
Total Number of Enclosures/Pods/Shelves Used	Details in section Storage Notes
Number of Physical Disks Used per Enclosure/Pod/Shelf	Details in section Storage Notes
Total Number of Storage Groups Used	Details in section Storage Notes
Number of LUNs Used	Details in section Storage Notes
LUN Size and Number of Disks Per LUN	Details in section Storage Notes

RAID Type	Details in section Storage Notes
Number of Members per RAID Set	Details in section Storage Notes
Disk Vendors, Models, and Speeds	<ul style="list-style-type: none"> • 2 x Seagate, Constellation.2 ST9250610NS, 7200 RPM, per host, 6 disks total • 4 x Intel, SSD DC S3510 SSDSC2BB800G6R, per host, 12 disks total

Datacenter Management Server

System Model	Dell PowerEdge C8220
Processor Vendor and Model	Intel Xeon E5-2650
Processor Speed (GHz)	2.00
Total Sockets/Total Cores/Total Threads	2 Sockets / 16 Cores / 32 Threads
Memory	128GB
Network Controller(s) Vendors and Models	Intel 1Gbps dual port I350 adapter, Mellanox ConnectX-3 adapter, connected at 10Gbps
Operating System, Version, Bitness, and Service Pack	Windows Server 2008 R2, Enterprise, 64-bit, Service Pack 1
Other Hardware	None
Other Software	None

Clients

Total Number of Clients / Total Physical Clients / Total Virtual Client Hosts	8 / 1 / 2
System Model(s)	Dell PowerEdge C8220 (used for all physical machines)
Processor Vendor(s) and Model(s)	Intel Xeon E5-2650
Processor Speed(s) (GHz)	2.0
Total Sockets/Total Cores/Total Threads	2 Sockets / 16 Cores / 32 Threads
Memory per Physical Client	128GB

Network Controller(s) Vendors and Models	Intel 1Gbps dual port I350 adapter, Mellanox ConnectX-3 adapter, connected at 10Gbps
Operating System, Version, Bitness, and Service Pack	<ul style="list-style-type: none"> • Microsoft Windows Server 2008 R2 Enterprise 64-bit (prime client) • VMWare ESXi 6.0 Update 2 Build 3620759 (virtual client hosts) • Microsoft Windows Server 2008 R2 Enterprise 64-bit (virtual clients)
Number of Virtual Clients	7
Number of vCPUs Per Virtual Client	4
Number of vMem (GB) Per Virtual Client	4
Virtual Client Networking Notes	All clients used virtual client hosts' 10Gbps vSwitch
Virtual Client Storage Notes	All clients stored on virtual client hosts' two disk RAID 1 volume
Other Hardware	None
Other Software	VMware ESXi 6.0 driver package version 3.15.2.0 for Mellanox (MEL-mlnx-3.15.2.0-3660328.zip)

Notes for Workload

Virtualization Software Notes

- Virtual hardware for all VMs was set to V11
- VMXNET3 adapter was used for all VMs
- Logging was disabled for all VMs (default enabled)
- All memory locked for all VMs with Sched.mem.pin = true (default false)
- All Linux and Mailserver VMs configured as single virtual socket with multiple cores (default one core per multiple virtual sockets)
- SCSI adapter type PVSCSI used for all Mailserver and Linux VMs (default LSI Logic SAS)
- CD and Floppy devices removed on all VMs (default enabled)
- vSphere DRS Migration Threshold set to Fully Automated level 4

Server Notes

None

Networking Notes

- vSwitch Configuration:
- vSwitch0 on vmnic5 (10Gb) for Service Console and all VMs except Olio VMs
- vSwitch1 on vmnic4 (10Gb) for vSAN
- vSwitch2 on vmnic6 (10Gb) for VMotion
- vSwitch3 on vmnic7 (10Gb) for iSCSI
- vSwitch4 on vmnic1 (10Gb) for all Olio VMs

Storage Notes

- ESX was installed on a two-disk RAID 1 volume from the internal SAS hard drives in each system under test
- 4 x Intel SSD DC S3500 were configured as non-RAID disks in the controller BIOS on each system under test
- Virtual SAN's Add disks to storage option was set to Manual (default Automatic)
- Virtual SAN was configured with a single disk group on each system under test
- Each disk group was configured with 1 x Intel SSD DC S3500 as cache tier, and 3 x Intel SSD DC S3500 as capacity tier
- All cache and capacity disks set as flash storage
- Virtual SAN Performance Service was turned ON (default OFF)
- All VMs were stored on the Virtual SAN datastore
- Virtual SAN VM Storage Policy was configured as follows:
- Force Provisioning set to Yes (default No)
- Object space reservation (%) set to 100 (default 0)
- Storage vMotion datastore created on a separate host with iSCSI (see below for details)
iSCSI Target Host
- Dell PowerEdge R630 with Dell PERC H730P Mini RAID Controller
- Red Hat Enterprise Linux Server release 7.2 installed on a RAID1 with 2 x SEAGATE ST300MM0006
- iSCSI Target created using Linux-IO Target with a BLOCK backstore on RAID1 with 2 x SanDisk LT0200MO
- iSCSI connected through an Intel 10-Gigabit X540-AT2 to the Dell Force10 S4810 10Gbps Switch

Datacenter Management Server Notes

- Microsoft Windows Server 2008 R2 Enterprise 64-bit installed on the Datacenter Management Server and updated through Windows Update
- VMware vSphere PowerCLI 5.8.0 Build 2057893 was installed on the Datacenter Management Server
- Mellanox ConnectX-3 adapter, connected at 10Gbps changed to ethernet mode (default InfiniBand)

Operating System Notes

None

Software Notes

None

Client Notes

- Prime client was running Microsoft Windows Server 2008 Service Pack 2 and VMware vSphere PowerCLI 5.8.0 Build 2057893
- Prime client ran on physical client 1
- Mellanox ConnectX-3 adapter, connected at 10Gbps on the prime client changed to ethernet mode (default InfiniBand)
- All virtual clients were defined with 4 virtual CPUs, 4GB of memory, 1 vmxnet3 network, and 60GB of disk space
- Virtual clients 0, 1, 2, and 3 were hosted on physical client 2
- Virtual clients 4, 5, and 6 were hosted on physical client 3
- Clients ran with default ESXi settings

Other Notes

None

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The next set of results are from our NVMe SSD configuration.

VMware® VMmark® V2.5.2 Results		
Vendor and Hardware Platform: Dell PowerEdge R630 Virtualization Platform: VMware ESXi 6.0 Update 2 Build 3825889 VMware vCenter Server : VMware vCenter Server 6.0 Update 2 Build 3634793		VMmark V2.5.2 Score = 14.42 @ 11 Tiles
Number of Hosts: 3	Uniform Hosts [yes/no]: no	Total sockets/cores/threads in test: 6/72/144
Tested By: Principled Technologies, Inc.		Test Date: [09-08-2016]
Performance Section Performance	Configuration Section Configuration	Notes Section Notes for Workload

Performance

mailserver		olio			dvdstoreA			dvdstoreB			dvdstoreC					
TILE_0	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	GM
p0	331.38	1.00	101.00	4768.35	1.03	53.52	3991.53	1.82	74.01	2965.12	1.95	81.43	2252.72	2.13	84.07	1.51
p1	328.70	1.00	104.00	4760.18	1.03	55.24	4564.82	2.08	47.06	3295.97	2.17	51.59	2378.38	2.25	53.95	1.60
p2	326.38	0.99	104.00	4765.93	1.03	55.75	4516.50	2.05	48.50	3383.43	2.23	52.74	2460.65	2.33	55.36	1.61
TILE_1	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	GM
p0	324.98	0.98	103.33	4777.62	1.03	53.76	3846.53	1.75	59.88	3161.97	2.08	66.96	2297.95	2.17	70.04	1.52
p1	326.50	0.99	103.30	4788.07	1.03	56.99	4098.85	1.86	47.30	3284.70	2.16	52.25	2362.88	2.23	54.98	1.56

p2	327.02	0.99	104.00	4789.50	1.03	60.04	3986.82	1.81	51.47	3403.05	2.24	56.20	2486.75	2.35	60.06	1.58
TILE_2	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	GM
p0	326.68	0.99	103.50	4760.07	1.03	51.42	4788.43	2.18	41.07	3565.25	2.35	45.67	2606.45	2.46	47.43	1.66
p1	326.35	0.99	104.00	4766.90	1.03	53.32	4723.38	2.15	42.83	3541.80	2.33	46.33	2575.97	2.43	48.84	1.65
p2	324.18	0.98	104.00	4790.65	1.03	56.47	4683.05	2.13	43.79	3499.60	2.30	48.08	2659.78	2.51	50.58	1.66
TILE_3	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	GM
p0	327.15	0.99	114.00	4781.68	1.03	52.02	4421.98	2.01	51.51	3312.20	2.18	56.06	2419.10	2.29	58.39	1.59
p1	325.40	0.99	124.00	4763.93	1.03	54.76	4516.07	2.05	48.44	3398.03	2.24	52.15	2587.55	2.45	54.15	1.63
p2	326.65	0.99	124.00	4782.00	1.03	56.76	4550.48	2.07	47.42	3402.47	2.24	51.85	2488.82	2.35	53.86	1.62
TILE_4	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	GM
p0	327.23	0.99	104.00	4780.15	1.03	52.62	4509.43	2.05	49.08	3495.05	2.30	53.05	2559.18	2.42	56.49	1.63
p1	328.77	1.00	104.00	4781.45	1.03	55.99	4497.85	2.05	48.97	3288.65	2.17	51.94	2485.28	2.35	54.03	1.61
p2	328.90	1.00	104.00	4773.18	1.03	63.63	4514.43	2.05	48.61	3369.90	2.22	53.43	2462.70	2.33	55.24	1.61
TILE_5	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	GM
p0	328.55	0.99	97.25	4773.60	1.03	50.93	4392.07	2.00	54.55	3296.22	2.17	59.27	2492.65	2.36	62.53	1.60
p1	323.93	0.98	104.00	4775.23	1.03	51.90	4572.10	2.08	46.86	3320.70	2.19	50.79	2375.03	2.24	54.06	1.59
p2	324.55	0.98	104.00	4780.80	1.03	53.90	4646.55	2.11	44.59	3485.88	2.30	48.73	2539.62	2.40	50.92	1.64
TILE_6	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	GM
p0	327.43	0.99	104.00	4766.85	1.03	52.56	4429.85	2.01	52.44	3203.32	2.11	56.87	2396.45	2.26	60.46	1.58
p1	327.95	0.99	109.97	4772.10	1.03	54.81	4620.65	2.10	45.58	3353.68	2.21	49.62	2406.12	2.27	52.30	1.61
p2	330.62	1.00	113.95	4763.68	1.03	56.71	4526.00	2.06	47.96	3524.07	2.32	51.58	2593.90	2.45	54.00	1.64
TILE_7	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	GM
p0	321.73	0.97	84.00	4789.73	1.03	54.44	4256.75	1.94	59.20	3056.35	2.01	63.89	2206.03	2.08	66.45	1.52
p1	324.45	0.98	84.00	4792.65	1.03	57.40	4337.23	1.97	54.21	3239.07	2.13	58.87	2347.22	2.22	62.30	1.57
p2	327.93	0.99	84.00	4771.77	1.03	58.99	4370.07	1.99	53.04	3247.35	2.14	58.35	2469.90	2.33	60.69	1.59
TILE_8	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	GM
p0	324.95	0.98	84.00	4767.82	1.03	52.82	4544.95	2.07	48.39	3293.03	2.17	52.40	2384.90	2.25	54.19	1.59
p1	326.65	0.99	83.25	4752.80	1.02	53.91	4565.02	2.08	47.13	3542.47	2.33	50.88	2598.50	2.46	53.80	1.64
p2	326.65	0.99	76.25	4780.38	1.03	57.65	4560.48	2.07	47.50	3292.28	2.17	52.28	2481.53	2.35	54.48	1.61
TILE_9	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	GM
p0	326.62	0.99	94.00	4760.05	1.03	52.94	4699.45	2.14	43.40	3526.15	2.32	47.11	2559.28	2.42	50.10	1.65
p1	327.00	0.99	94.00	4789.38	1.03	56.81	4613.60	2.10	45.62	3462.28	2.28	49.62	2635.15	2.49	51.83	1.65
p2	327.25	0.99	94.00	4785.62	1.03	59.50	4633.90	2.11	45.07	3385.12	2.23	48.56	2421.80	2.29	51.67	1.61
TILE_10	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	Actual	Ratio	QoS	GM
p0	330.23	1.00	104.00	4766.52	1.03	53.89	4202.30	1.91	44.13	3481.60	2.29	48.82	2652.57	2.51	51.19	1.62
p1	327.07	0.99	104.00	4792.88	1.03	57.52	4254.77	1.93	42.37	3536.62	2.33	46.92	2562.85	2.42	49.79	1.62
p2	324.82	0.98	104.00	4776.00	1.03	58.00	4163.38	1.89	45.35	3342.72	2.20	49.83	2402.82	2.27	52.25	1.57

p0_score:	17.48
p1_score:	17.72
p2_score:	17.74

Infrastructure_Operations_Scores:	vmotion	svmotion	deploy
Completed_Ops_PerHour	18.50	10.00	5.50
Avg_Seconds_To_Complete	13.70	52.20	321.35
Failures	0.00	0.00	0.00
Ratio	1.16	1.11	1.38
Number_Of_Threads	1	1	1

Summary	Run_Is_Compliant	Turbo_Setting:0
	Number_Of_Compliance_Issues(0)*	Median_Phase(p1)
Unreviewed_VMmark2_Applications_Score	17.72	
Unreviewed_VMmark2_Infrastructure_Score	1.21	
Unreviewed_VMmark2_Score	14.42	

Configuration

Virtualization Software	
Hypervisor Vendor, Product, Version, and Build / Availability Date (MM-DD-YYYY)	VMware ESXi, 6.0 Update 2, Build 3825889 / 05-12-2016
Datacenter Management Software Vendor, Product, Version, and Build / Availability Date (MM-DD-YYYY)	VMware vCenter Server, 6.0 Update 2, Build 3634793 / 03-16-2016
Supplemental Software	None
Servers	
Quantity	3
Server Manufacturer and Model	Dell PowerEdge R630
Processor Vendor and Model	Intel Xeon E5-2670V3
Processor Speed (GHz)	2.30

Total Sockets/Total Cores/Total Threads	2 Sockets / 24 Cores / 48 Threads
Primary Cache	32KB I + 32KB D on chip per core
Secondary Cache	256KB I+D on chip per core
Other Cache	30MB I+D on chip per chip
BIOS Version	2.1.6
Memory Size (in GB, Number of DIMMs)	256GB, 8
Memory Type and Speed	32GB DIMMs 2Rx4 DDR4-2133MHz Registered ECC
Disk Subsystem Type	vSAN
Number of Disk Controllers	1
Disk Controller Vendors and Models	Dell PERC H730 Mini on SUT 1 Dell PERC H730P Mini on SUT 2 and 3
Number of Host Bus Adapters	0
Host Bus Adapter Vendors and Models	None
Number of Network Controllers	4
Network Controller Vendors and Models	1 x Intel 1Gbps dual port I350 adapter (embedded), 1 x Intel 82599EB 10-Gigabit SFI/SFP+ adapter (embedded) 2 x Intel 82599EB 10-Gigabit SFP+
Other Hardware	None
Other Software	VMware ESXi 6.0 driver package version 6.903.85.00 for Dell PERC H730/P Mini (VMW-ESX-6.0.0-lsi_mr3-6.903.85.00_MR-3818071.zip) VMware ESXi 5.5 driver package version 1.0e.2.0 for Intel NVMe drives (VMW-ESX-5.5.0-intel-nvme-1.0e.2.0-3132116.zip)
Hardware Availability Date (MM-DD-YYYY)	03-01-2016
Software Availability Date (MM-DD-YYYY)	05-12-2016
Network	

Network Switch Vendors and Models	Dell Force10 S4810
Network Speed	10Gbps
Storage	
Array Vendors, Models, and Firmware Versions	VMware Virtual SAN Details in section Storage Notes
Fibre Channel Switch Vendors and Models	None
Disk Space Used	5.97TB
Array Cache Size	Details in section Storage Notes
Total Number of Physical Disks Used	18
Total Number of Enclosures/Pods/Shelves Used	Details in section Storage Notes
Number of Physical Disks Used per Enclosure/Pod/Shelf	Details in section Storage Notes
Total Number of Storage Groups Used	Details in section Storage Notes
Number of LUNs Used	Details in section Storage Notes
LUN Size and Number of Disks Per LUN	Details in section Storage Notes
RAID Type	Details in section Storage Notes
Number of Members per RAID Set	Details in section Storage Notes
Disk Vendors, Models, and Speeds	<ul style="list-style-type: none"> • 2 x Seagate, Constellation.2 ST9250610NS, 7200 RPM, per host, 6 disks total • 4 x Intel, DC P3600 NVMe PCIe SSD SSDPE2ME020T4, per host, 12 disks total
Datacenter Management Server	
System Model	Dell PowerEdge C8220

Processor Vendor and Model	Intel Xeon E5-2650
Processor Speed (GHz)	2.00
Total Sockets/Total Cores/Total Threads	2 Sockets / 16 Cores / 32 Threads
Memory	128GB
Network Controller(s) Vendors and Models	Intel 1Gbps dual port I350 adapter, Mellanox ConnectX-3 adapter, connected at 10Gbps
Operating System, Version, Bitness, and Service Pack	Windows Server 2008 R2, Enterprise, 64-bit, Service Pack 1
Other Hardware	None
Other Software	None

Clients	
Total Number of Clients / Total Physical Clients / Total Virtual Client Hosts	12 / 1 / 3
System Model(s)	Dell PowerEdge C8220 (used for all physical machines)
Processor Vendor(s) and Model(s)	Intel Xeon E5-2650
Processor Speed(s) (GHz)	2.0
Total Sockets/Total Cores/Total Threads	2 Sockets / 16 Cores / 32 Threads
Memory per Physical Client	128GB
Network Controller(s) Vendors and Models	Intel 1Gbps dual port I350 adapter, Mellanox ConnectX-3 adapter, connected at 10Gbps
Operating System, Version, Bitness, and Service Pack	<ul style="list-style-type: none"> • Microsoft Windows Server 2008 R2 Enterprise 64-bit (prime client) • VMWare ESXi 6.0 Update 2 Build 3620759 (virtual client hosts) • Microsoft Windows Server 2008 R2 Enterprise 64-bit (virtual clients)
Number of Virtual Clients	11
Number of vCPUs Per Virtual Client	4
Number of vMem (GB) Per Virtual Client	4

Virtual Client Networking Notes	All clients used virtual client hosts' 10Gbps vSwitch
Virtual Client Storage Notes	All clients stored on virtual client hosts' two disk RAID 1 volume
Other Hardware	None
Other Software	VMware ESXi 6.0 driver package version 3.15.2.0 for Mellanox (MEL-mlnx-3.15.2.0-3660328.zip)

Notes for Workload

Virtualization Software Notes

- Virtual hardware for all VMs was set to V11
- VMXNET3 adapter was used for all VMs
- Logging was disabled for all VMs (default enabled)
- All memory locked for all VMs with Sched.mem.pin = true (default false)
- All Linux and Mailserver VMs configured as single virtual socket with multiple cores (default one core per multiple virtual sockets)
- SCSI adapter type PVSCSI used for all Mailserver and Linux VMs (default LSI Logic SAS)
- CD and Floppy devices removed on all VMs (default enabled)
- vSphere DRS Migration Threshold set to Fully Automated level 4

Server Notes

None

Networking Notes

- vSwitch Configuration:
- vSwitch0 on vmnic5 (10Gb) for Service Console and all VMs except Olio VMs
- vSwitch1 on vmnic4 (10Gb) for vSAN
- vSwitch2 on vmnic6 (10Gb) for VMotion
- vSwitch3 on vmnic7 (10Gb) for iSCSI
- vSwitch4 on vmnic1 (10Gb) for all Olio VMs

Storage Notes

- ESX was installed on a two-disk RAID 1 volume from the internal SAS hard drives in each system under test
- 4 x Intel NVMe PCIe SSD DC P3600 were configured as non-RAID disks in the controller BIOS on each system under test
- Virtual SAN's Add disks to storage option was set to Manual (default Automatic)
- Virtual SAN was configured with a single disk group on each system under test
- Each disk group was configured with 1 x Intel NVMe PCIe SSD DC P3600 as cache tier, and 3 x Intel NVMe PCIe SSD DC P3600 as capacity tier
- All cache and capacity disks set as flash storage
- Virtual SAN Performance Service was turned ON (default OFF)
- All VMs were stored on the Virtual SAN datastore

- Virtual SAN VM Storage Policy was configured as follows:
- Force Provisioning set to Yes (default No)
- Object space reservation (%) set to 100 (default 0)
- Storage vMotion datastore created on a separate host with iSCSI (see below for details)
iSCSI Target Host
- Dell PowerEdge R630 with Dell EMC PERC H730P Mini RAID Controller
- Red Hat Enterprise Linux Server release 7.2 installed on a RAID1 with 2 x SEAGATE ST300MM0006
- iSCSI Target created using Linux-IO Target with a BLOCK backstore on RAID1 with 2 x SanDisk LT0200MO
- iSCSI connected through an Intel 10-Gigabit X540-AT2 to the Dell Force10 S4810 10Gbps Switch

Datacenter Management Server Notes

- Microsoft Windows Server 2008 R2 Enterprise 64-bit installed on the Datacenter Management Server and updated through Windows Update
- VMware vSphere PowerCLI 5.8.0 Build 2057893 was installed on the Datacenter Management Server
- Mellanox ConnectX-3 adapter, connected at 10Gbps changed to ethernet mode (default InfiniBand)

Operating System Notes

None

Software Notes

None

Client Notes

- Prime client was running Microsoft Windows Server 2008 Service Pack 2 and VMware vSphere PowerCLI 5.8.0 Build 2057893
- Prime client ran on physical client 1
- Mellanox ConnectX-3 adapter, connected at 10Gbps on the prime client changed to ethernet mode (default InfiniBand)
- All virtual clients were defined with 4 virtual CPUs, 4GB of memory, 1 vmxnet3 network, and 60GB of disk space
- Virtual clients 0, 1, 2, and 3 were hosted on physical client 2
- Virtual clients 4, 5, 6, and 7 were hosted on physical client 3
- Virtual clients 8, 9, and 10 were hosted on physical client 4
- Clients ran with default ESXi settings

Other Notes

None

This is a full disclosure report for a VMmark benchmark result. All published VMmark results must be from fully compliant tests for which a full disclosure report is publicly available.

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