

Using Solid State Disks in VDI Environments

This whitepaper describes a proof-of-concept in which solid state disks were used in a virtual desktop infrastructure for Windows 7 desktops based on VMware View 4.5. The results of the tests and investigations enable our consultants to define an optimum architecture and do the right sizing. Existing problems such as boot storms can easily be solved. Furthermore, financial aspects are considered and a future outlook of SSD technology is given.



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SSD (Solid State Disks)

Solid state disks are becoming increasingly popular. It all started several years ago with the so-called memory sticks. These were available in versions from 4 to 64 MB; they were small and could be easily connected via a USB interface. The information was written to a flash memory. Today, memory sticks have completely replaced the floppy disk drives. There is no better alternative to transport data quickly with regard to price, size, easy usage, reliability, robustness and capacity. Today's USB sticks are available in sizes between 2 and 64 GB; the price is approx. €2 per GB and decreasing.

A further use case for solid state disks was storing images on SMART or flash cards in digital cameras. Capacities ranged between 16 and 256 MB. If 1 GB memory and more was required, then very small conventional disks were used, the so-called micro drives.

This triggered fast technological developments that have resulted in ever-increasing memory capacities at reduced prices, driven mainly by the usage in mobile phone and digital camera applications.

As soon as memory chip capacities had reached a certain size, constructing fast memory disks became interesting. There was a development earlier where part of the computer's memory or a separate card was configured as a so-called RAM disk. However, use cases of such a "high-speed memory" were rather limited, because of low capacities but high costs. Today, it is still usual to integrate solid state disks as a cache on conventional disk drives in order to increase throughput.

Today, solid state disks range from 100 to 400 GB with prices between €200 and €1,400 in the consumer segment and €1,000 to €4,000 in the business segment. It is technically possible to have sizes of more than 1 TB in a 2.5" form factor.

Solid State Disks have the following features:

- They are robust and can withstand vibrations.
- They have no moving parts and have therefore a longer life span with lower failure rates (and tremendously improved MTBF)
- Compared to standard disks, their I/O throughput is 10 to 30 times higher
- They use less power and thus generate less heat
- They are less sensitive to environmental influences, such as magnetic fields, pressure fluctuations, vibrations and extreme temperatures.

The following disadvantages exist today:

- At a certain extent, the limited number of write cycles
- Lower capacities (in comparison to conventional disks)
- High price

There is a difference between SSDs for the consumer segment and those for the business segment. The disks for the consumer segment are relatively inexpensive today, but have a notably lower number of maximum write cycles. The disks for the business segment have a notably higher number of write cycles which is also reflected in the price. The type of memory chips used also plays a role, especially with regard to the quality-related features. SSDs are available as flash memories and SDRAM memories. There are further differences (e.g. NOR/NAND-based). Generally, special chips are selected in the business segment, which justifies the higher price in comparison to the consumer segment.

Summary of typical use cases:

- Flash-based memories in MP3 players and cameras
- Flash memories are also used as USB sticks and as BIOS memories in PCs
- SDRAM-based SSDs in storage systems, notebooks and servers

Due to the parameters mentioned above, the price of SSDs today makes them interesting in data centers with:

- Clear and manageable data quantities
- Densely populated data centers with cooling and power requirement problems
- Short load and start phases (system start)
- Availability (MTBF)
- Special environmental requirements

Note:

In this document we speak of virtual desktops, workloads and VMs, which is basically one and the same thing.

Can SSD be helpful in Virtual Desktop Infrastructures?

In order to figure out, if and which situations Solid State Disks are a recommendable alternative in virtual desktop infrastructures, Fujitsu decided to perform a number of tests. In this context, not only technical viability, advantages and impacts of SSD technology should be considered, but also financial aspects, such as costs per virtual machine, potential savings and economic benefits.

Test infrastructure

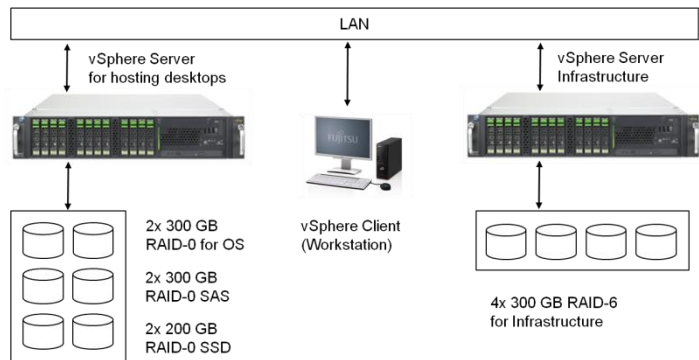
For the purpose of the tests, a test infrastructure based on VMware View 4.5 with View Composer was built up.

Using "linked clone" technology, VMware View Composer reduces storage requirements by up to 70% and simultaneously optimizes desktop image administration by enabling fast creation and updates of desktop images which use a virtual hard disk together with a master image. View Composer is used by IT organizations to manage several hundred or thousand desktops with one single image. New virtual machines simply link to the virtual hard disk of the master VM (Replica VM). Any changes at runtime are saved in a delta file which can be automatically deleted when a user logs off.

The VSI (Virtual Session Indexer) benchmark tool from Login Consultants was used for the measurement, once using conventional hard disks and once using SSD. A more detailed explanation is provided later in this document.

To be clear: all results are related to the chosen test infrastructure. And of course there will always be discussions, whether to use SSD internally in the servers or in a central storage system. This question will strongly depend on the general architecture and should be considered separately. However, the results from this test can be used in the decision process.

The test infrastructure looks as follows:



Two Fujitsu PRIMERGY RX300 S6 industry standard servers are connected with each other via a GB Ethernet switch. For administration purposes, a workstation device is additionally integrated in the network. One of the Fujitsu PRIMERGY RX300 servers is used as an infrastructure server for services, such as domain controller, DHCP and DNS server, and the other Fujitsu PRIMERGY RX300 (desktop server) is used for hosting the virtual desktop machines.

Hardware configuration of the infrastructure server

Fujitsu PRIMERGY RX300 S6

- 12 cores 2.66 GHz, Hyperthreading Enabled
- 72 GB RAM
- 2 GB Ethernet network adapter (onboard)
- 4x 300 GB SAS HD RAID-6 as logical drives for the hypervisor and all required virtual servers

Software on the infrastructure server

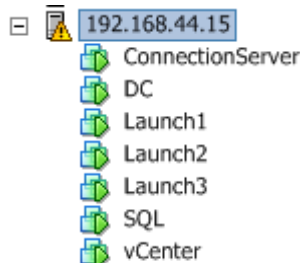
Hypervisor ESX-4.1.0-Update01-348481.iso

DC	Windows Server 2008 R2 AD, DNS, DHCP
vCenter	Windows Server 2008 R2 VMware-VIMSetup-all-4.1,0-345042.iso VMware-viewcomposer-2.6.0-349155.exe
SQL	Windows Server 2008 R2 MS SQL Server 2008 + SP1
View	Windows Server 2008 R2 VMware-viewconnectionserver-x86_64-4.6.0-366101.exe

VSI Login 3.0 Express (Medium workload, RDP protocol)

Launcher1	Windows 7 Enterprise Edition VSI Login 3.0
Launcher2	Windows 7 Enterprise Edition VSI Login 3.0
Launcher3	Windows 7 Enterprise Edition VSI Login 3.0

All virtual machines at a glance:



Connection Server	VMware View Manager
DC	Domain Controller
SQL	SQL Server Data store
vCenter	VMware vCenter
Launch1-3	Windows 7 Clients as Launcher

Installation process

- DC with Active Directory, DNS, DHCP, VSI AD configuration
- SQL Server
- vCenter with configuration DB on SQL Server
- ConnectionServer with configuration to vCenter and SQL Server
- VMware View Composer on vCenter Server with configuration to SQL Server
- 3 Windows 7 Clients (Launch1-3) with VMware tools and VSI launch configuration.
- VSI Analyser additionally on Launch 1

Hardware configuration of the desktop server

Fujitsu PRIMERGY RX300 S6

- 12 Cores 2.66 GHz, Hyperthreading Enabled
- 144 GB RAM
- 2 GB Ethernet network adapter (onboard)
- 2x 300 GB SAS HD RAID-1 as logical drives for the hypervisor and the virtual desktop machine based on the Windows 7 template.
- 2x 300 GB SAS HD RAID-0 as logical drives
- 2x 200 GB SSD RAID-0 as logical drives

Software on the desktop server

Hypervisor	ESX-4.1.0-Update01-348481.iso
W7Template	Windows 7 Enterprise Edition (32 Bit) En VMware tools Optimization according to the document: VMware-View-Optimization GuideWindows7-EN.pdf
View Agent:	VMware-viewagent-4.6.0-366101.exe Office 2007 Enterprise Edition En
Installation W7Template	Windows 7 Enterprise VMware tools Office 2007 Enterprise En VMware Optimizations for Windows 7 VMware View Agent 4.60 VSI target configuration Ipconfig /Release 1 vCPU, 1024 MB RAM, 30 GB HD, DHCP

Test software

The VSI (Virtual Session Indexer) Analyser from Login Consultants was used as a benchmark tool. It is independent of platform and hypervisor; thus our test could be replicated on other platforms at any time. The tool is easy to install and can be downloaded free of charge from <http://www.loginconsultants.com/>.

The VSI Analyzer supports:

- Windows-based Presentation Virtualization platforms (Server Based Computing)
- Windows-based Virtual Desktop Infrastructures
- Windows-based Application Virtualization platforms (Application Streaming)
- Windows 32 Bit and Windows x64
- Windows XP, 2003, Vista, Win7 and 2008 & 2008R2
- Office 2003, 2007 (Preferred) and 2010 Technical Preview
- Citrix, VMware, ProVision IT and other presentation or desktop virtualization vendors through a custom command line to launch sessions.

Various applications are used and measured as workload, such as Notepad, zip, and so on. A description (Admin Manual) is also available on the homepage of Login Consultants.

Subsequently we show a short excerpt of VSI operation and an interpretation of the results:

VSI is specifically not a steady state test. VSI, a solution for benchmarking TS (Terminal Services) or VDI (Virtual Desktop Infrastructure) workloads, loads the system with simulated user workloads. VSI focuses on how much users can run on the system before it saturates. VSI is similar to investigating the maximum amount of seats on the bus, airplane or lifeboat by trial and error through system saturation. This is the "Virtual Session Index (VSI)". With VDI and TS workloads this is very valid and useful information. This index simplifies comparisons and makes it possible to understand the true impact of configuration changes at hypervisor host or guest level.

Use the analysis tool to determine the VSImax, which is the maximum capacity of the tested system expressed in the amount of VSI sessions. With VSImax, this means the following:

- VSImax corrected value = VSImax without hanging VMs
- VSImax uncorrected value = VSImax with hanging VMs

Ideally, if both values are identical, then nothing is hanging. With regards to sizing, the corrected value should always be used or calculated.

Allgemein	
Gastbetriebssystem:	Microsoft Windows 7 (32-Bit)
VM-Version:	7
CPU:	1 vCPU
Arbeitsspeicher:	1024 MB
Arbeitsspeicher-Overhead:	105,91 MB
VMware Tools:	OK
IP-Adressen:	192.168.44.215
DNS-Name:	WIN7-115.test.local
EVC-Modus:	Nicht verfügbar
Zustand:	Eingeschaltet
Host:	192.168.44.10
Aktive Aufgaben:	

There are two ways to calculate VSI_{max}, the dynamic way and the classic way.

Dynamic – Is the new, more precise calculation method as of VSI 3.x. The average response time of the first 15 VMs (under the tab "VSI_{Max} Data" in the column "VSIIndex_avg") is defined as the baseline, e.g. 1500ms. An additional fixed value is added to the baseline (Analyzer Default + 3000ms). In this example, the VSI_{max} would activate at 4500ms; this value should be in a steep climbing curve for the response time pattern. Otherwise the impact (3000ms) would be more sensible as selection (however, it usually works).

All default parameters for the analyser calculations can be seen in the analyser tool under "File" → "Preferences" in the value "Dynamic VSI_{Max}" and "VSI_{Max} Calculation".

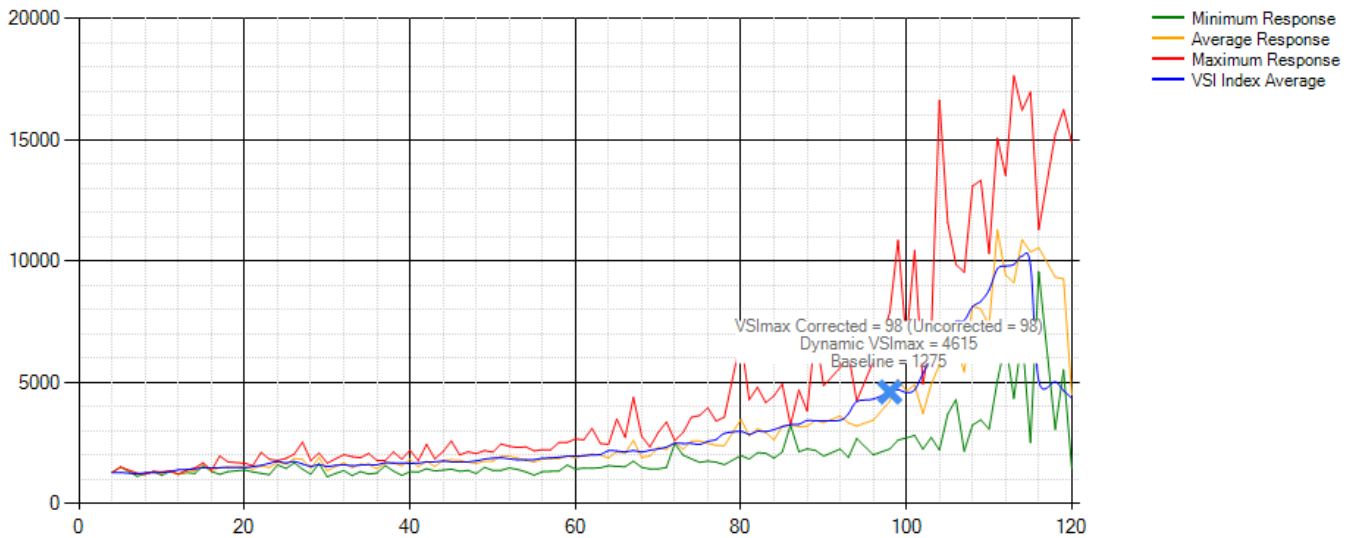
Classic – Is the old calculation method from VSI 2.x, which should no longer be used.

Old logs can also be analyzed with the new analyzer and determined according to the dynamic method

A typical result (taken from Login Consultants) looks as follows:

Vertical axis: Response time in milliseconds
Horizontal axis: Total active sessions

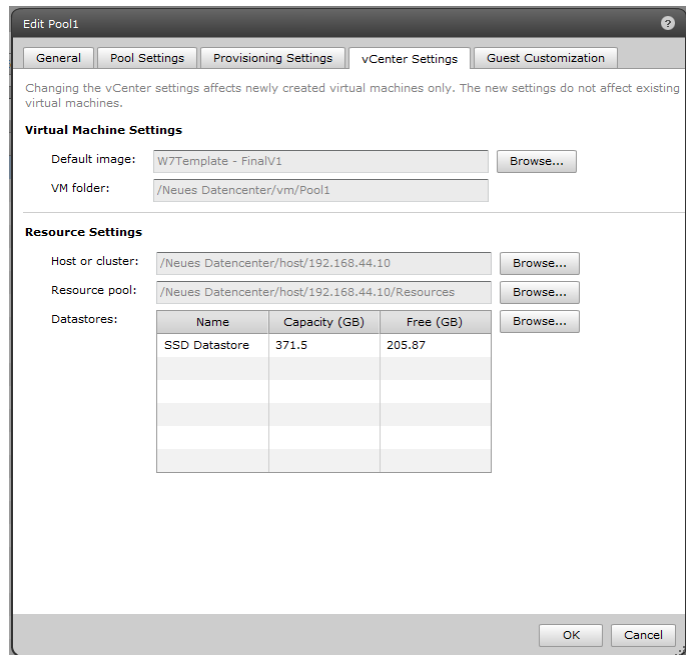
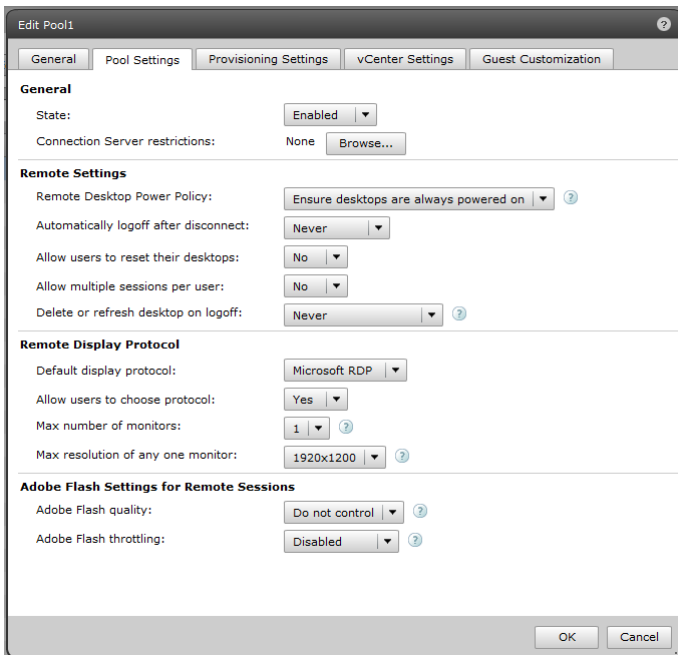
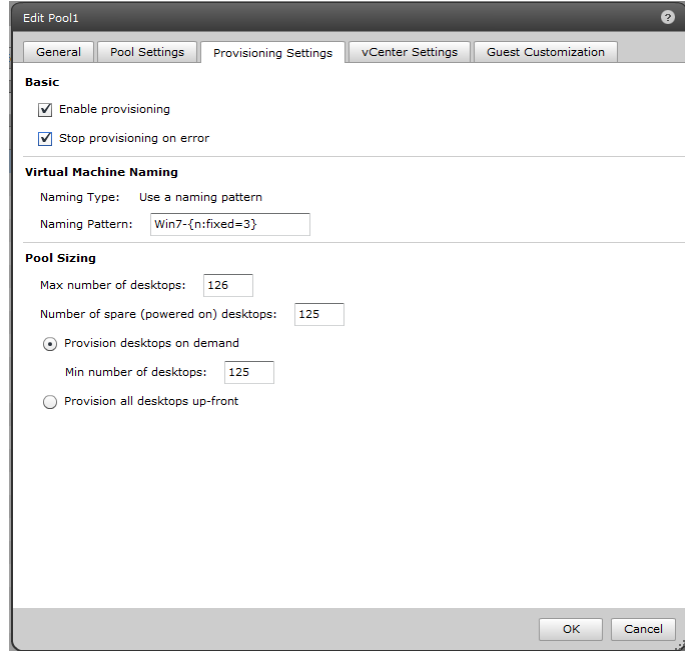
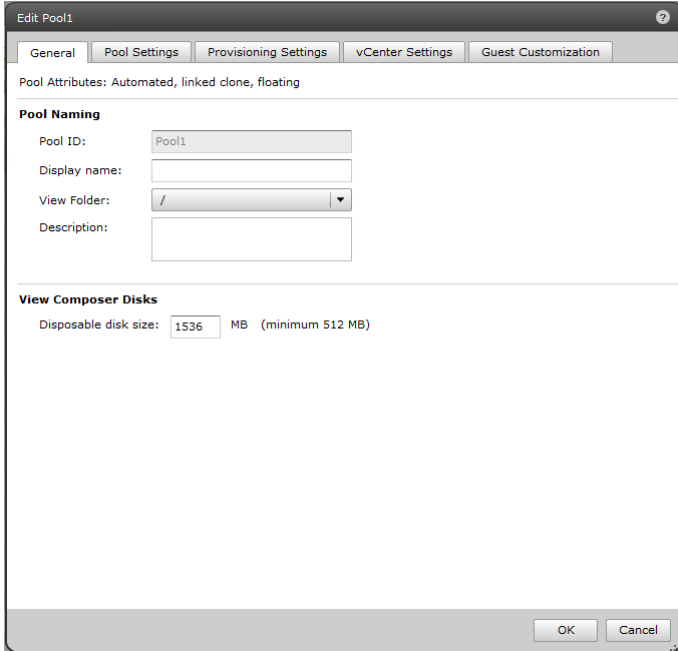
- Minimum response Best response time of an individual measurement within a single session
- Maximum response Worst response time of an individual measurement within a single session
- Average response Average response time within all sessions
- VSI Index Average Maximum capacity of the tested system expressed in the amount of VSI sessions.

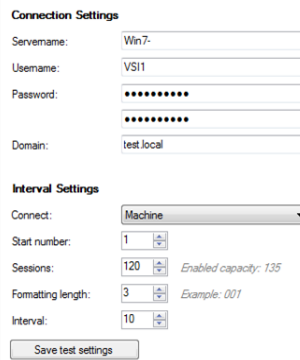
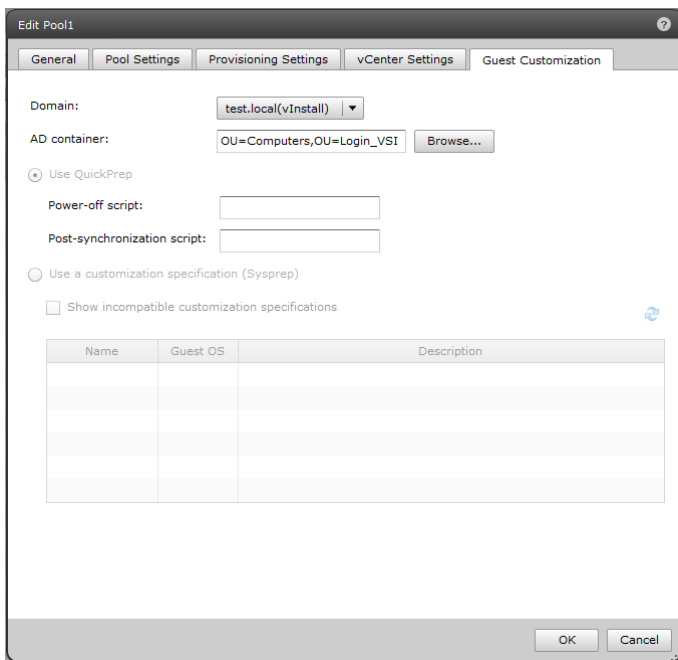


Virtual machines on SSD data store

Test preparation

Create 120 virtual machines based on W7Template and View Composer for deployment on SSD data store (floating users)

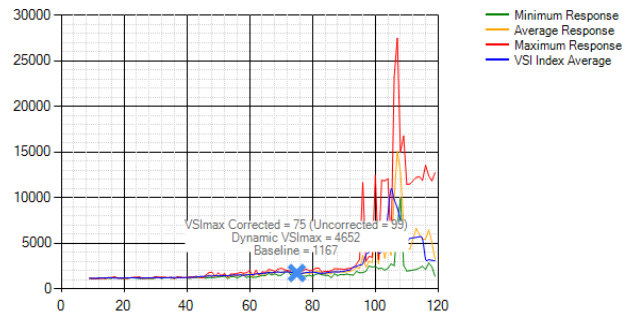




VSI Login Analyser

Analysis of the test result using VSI Login Analyser:

Evaluation type: Dynamic



Test results

Everything (replica and linked clones) on SSD data store.
Time required for completion: ~35 minutes.

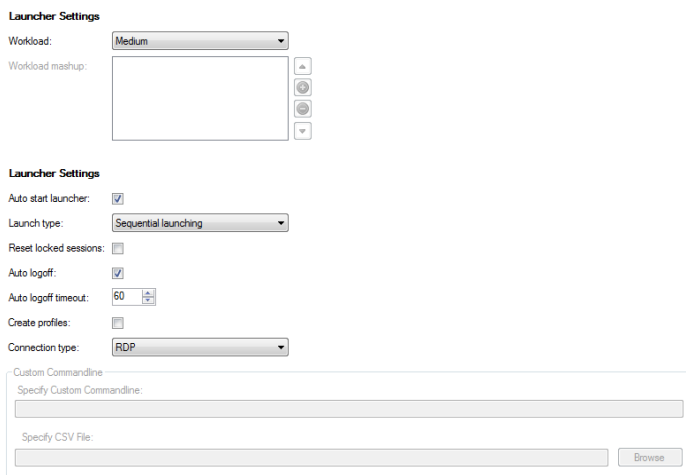
Configuration of the VSI Login management console

All launchers rebooted. All virtual machines rebooted

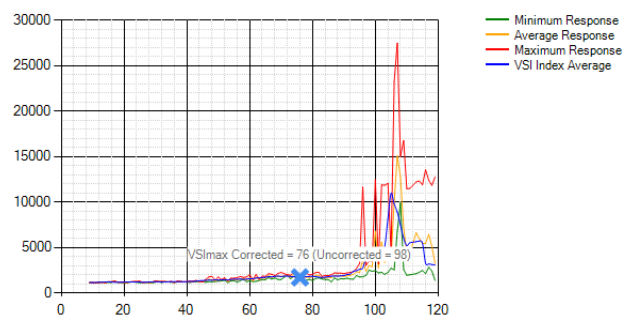
Launchers

Launcher name	Enabled	Capacity
1. Launch1	Enabled	45
2. Launch2	Enabled	45
3. Launch3	Enabled	45

Test Configuration



Evaluation type: Classic

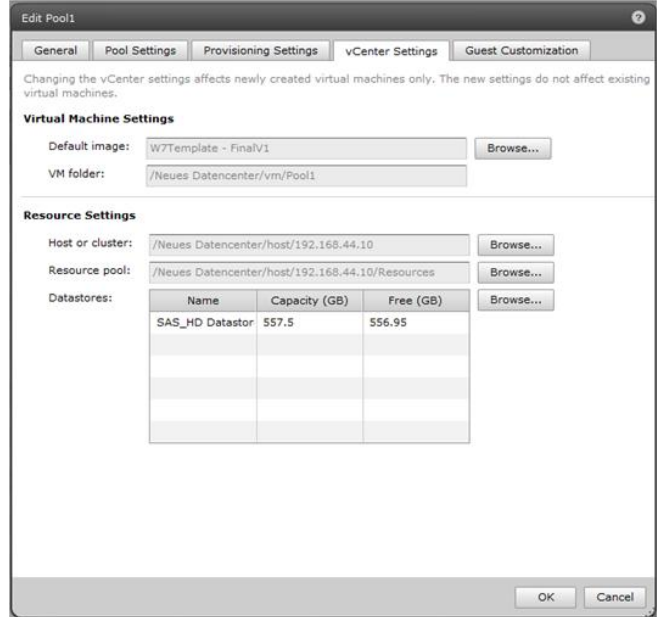
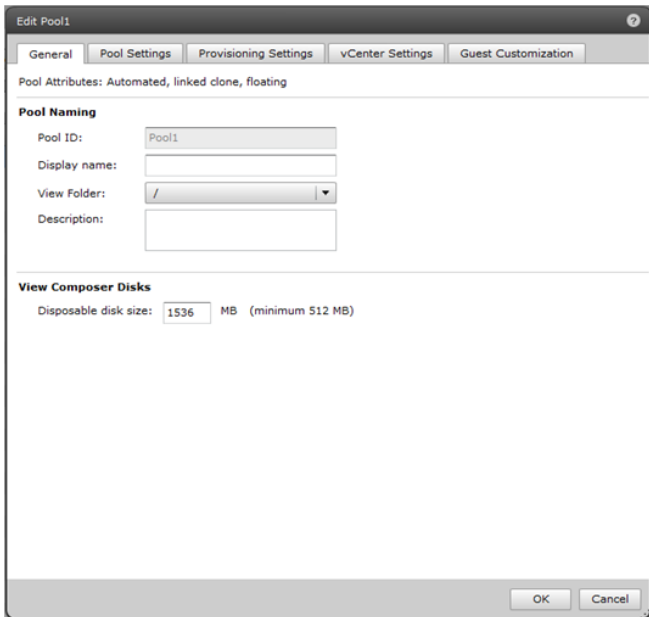
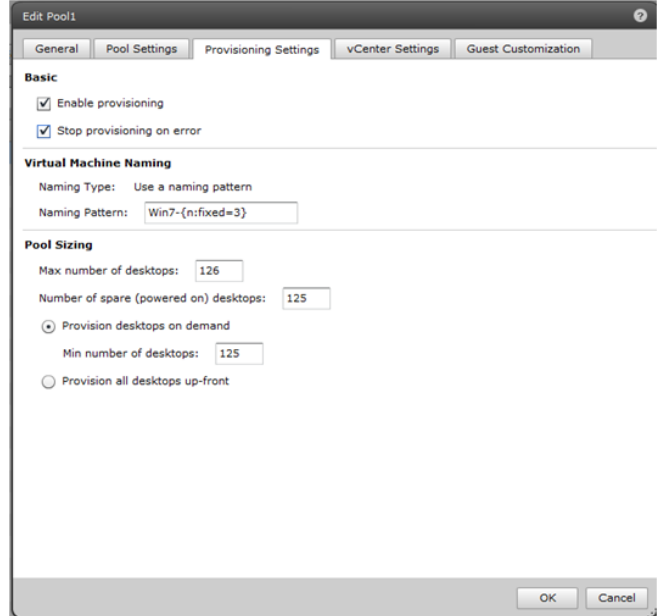
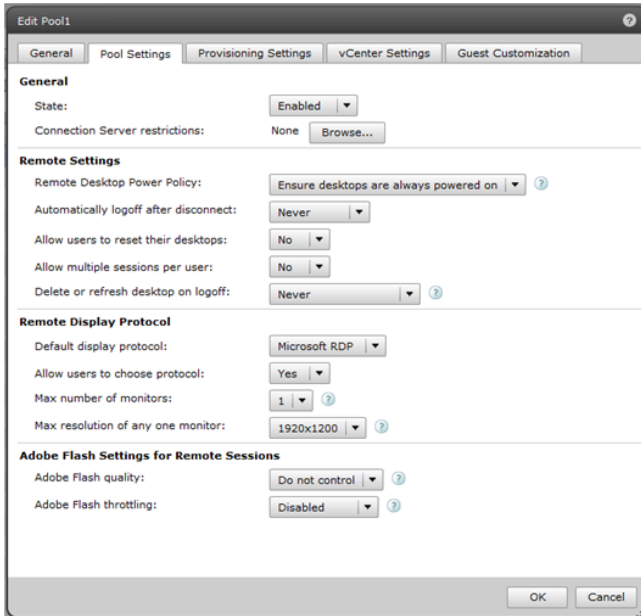


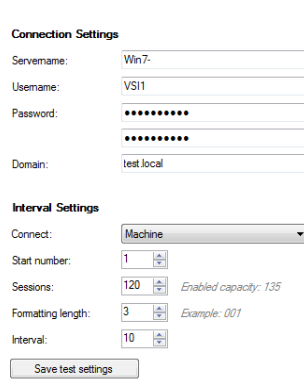
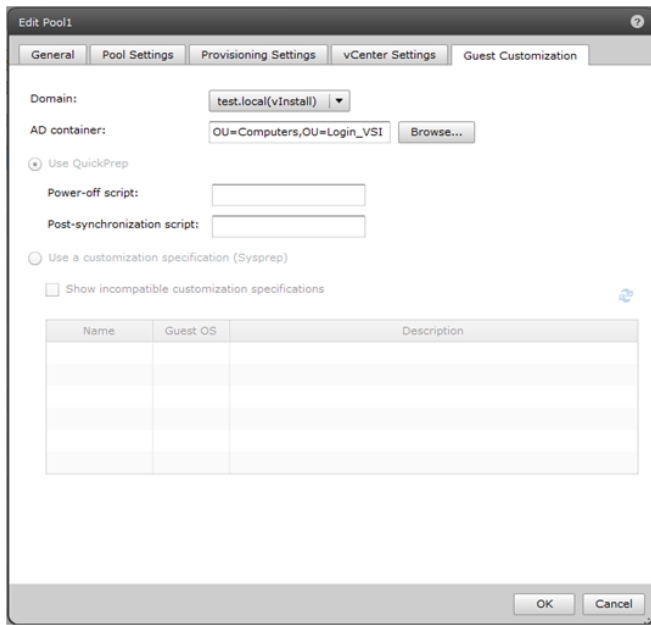
After having analyzed the results, delete the virtual machines on the SSD data store.

Virtual machines on SAS data store

Test preparation

Create 120 virtual machines based on W7Template and View Composer for deployment on SAS data store (floating users)





New test with less virtual desktops on SAS data store

The test with 120 VM with linked clones on SAS data store always aborted with an error message (too many I/O). The number of virtual machines thus had to be reduced to **50** in order to ensure a successful operation of the VSI Login Test.

Test result

Everything (replica disk and linked clones) on SAS data store. Time required for completion: ~3.5 to 4 hours.

Two results can be determined in the meantime. With SSD, the deployment of 120 virtual desktops is six times faster than with conventional disks in the same environment. It can also be said that the limit of possible workloads with conventional disks could occur earlier due to I/O. In order to obtain comparable figures, the test was continued with a reduced number of workloads.

Configuration of the VSI Login Management console

All launchers rebooted. All virtual machines rebooted.

Reconfiguration of the VSI Login Test

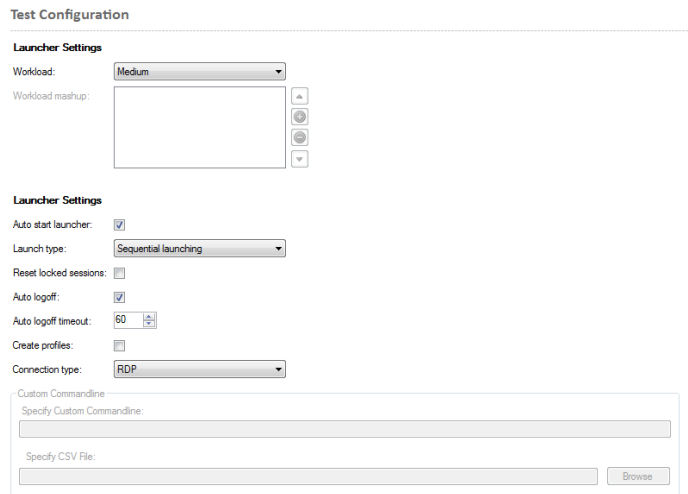
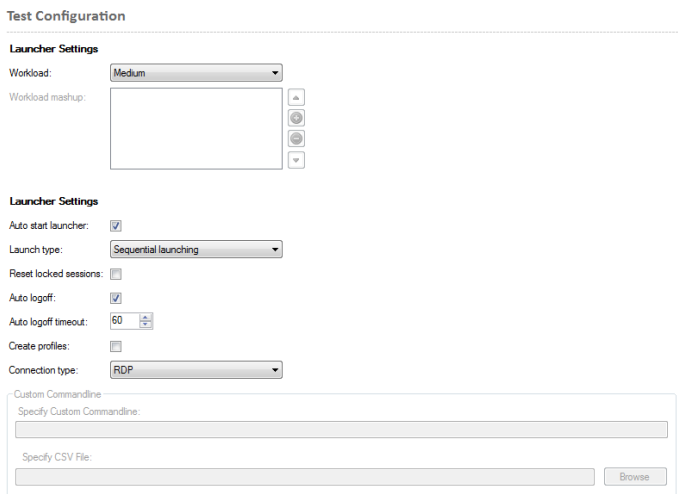
All launchers rebooted. All virtual machines rebooted.

Launchers

Launcher name	Enabled	Capacity
1. Launch1	Enabled	45
2. Launch2	Enabled	45
3. Launch3	Enabled	45

Launchers

Launcher name	Enabled	Capacity
1. Launch1	Enabled	30
2. Launch2	Enabled	30
3. Launch3	Enabled	30



Connection Settings

Servername: Win7-
 Username: VSI1
 Password: *****
 Domain: test.local

Interval Settings

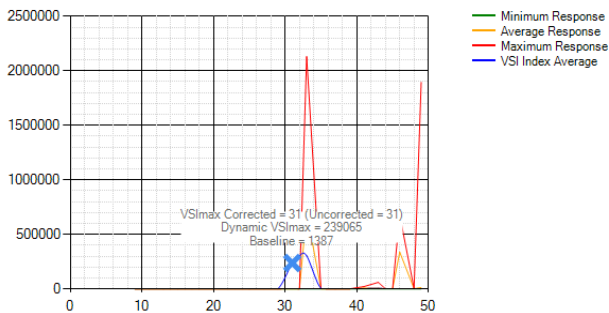
Connect: Machine
 Start number: 1
 Sessions: 80 *Enabled capacity: 90*
 Formatting length: 3 *Example: 001*
 Interval: 10

Save test settings

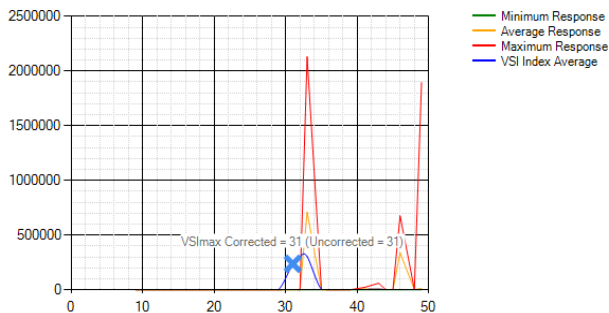
VSI Login Analyzer

Analysis of the test result using VSI Login Analyzer:

Evaluation type: Dynamic



Evaluation type: Classic



After having analyzed the results, delete the virtual machines on the SAS data store.

Results of the test

With SSD, 75 workloads are possible on the same system. If conventional disks are used, it will be only 31 workloads. The bottleneck is neither the CPU nor memory, but the I/O.

Replicas on SSD, linked clones on SAS

Finally, another test was performed as a comparison whereby each virtual machine is configured with 2 GB RAM. While preventing memory over-commitment, the number of possible virtual machines was set to 70 VMs in the hypervisor, having 144 GB RAM in the server.

Create virtual machines

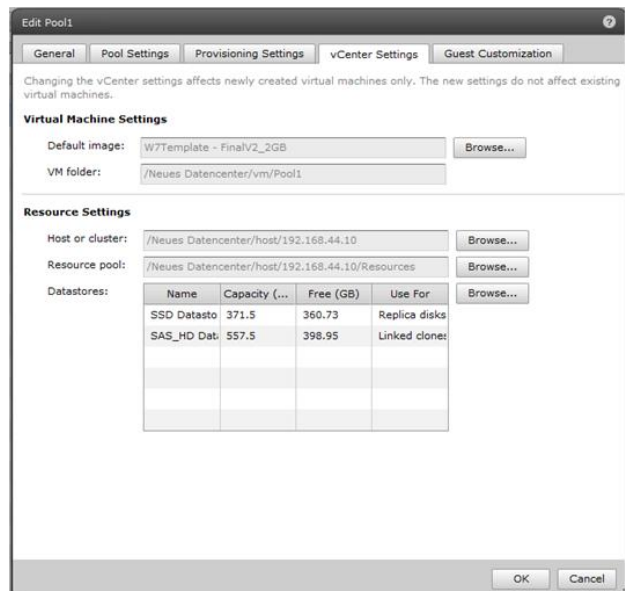
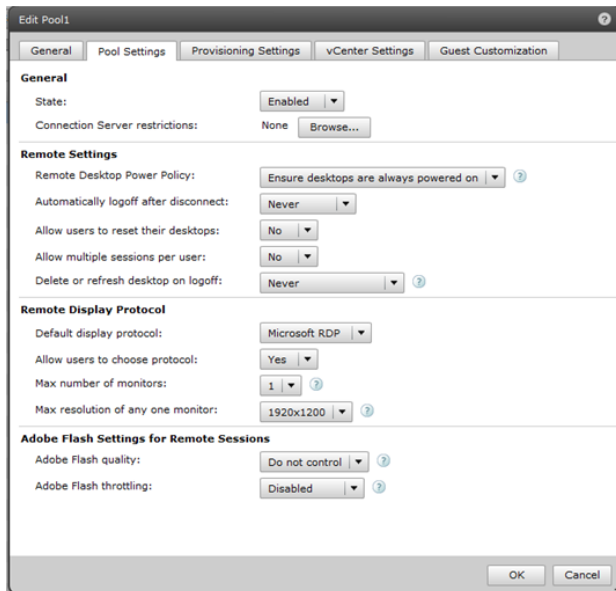
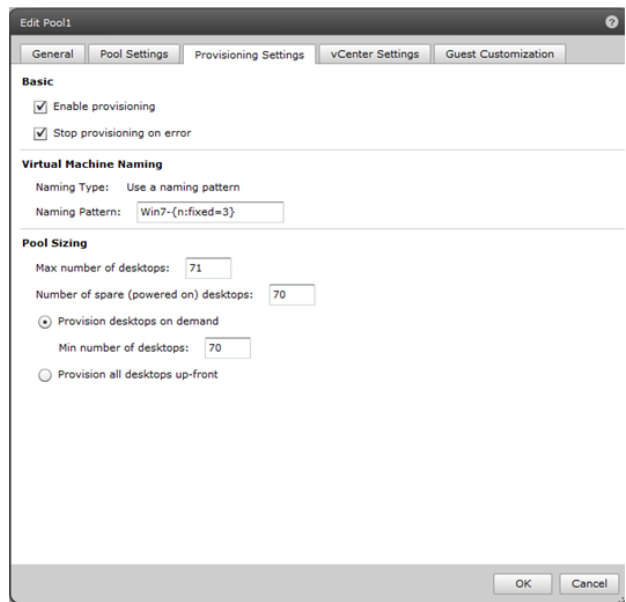
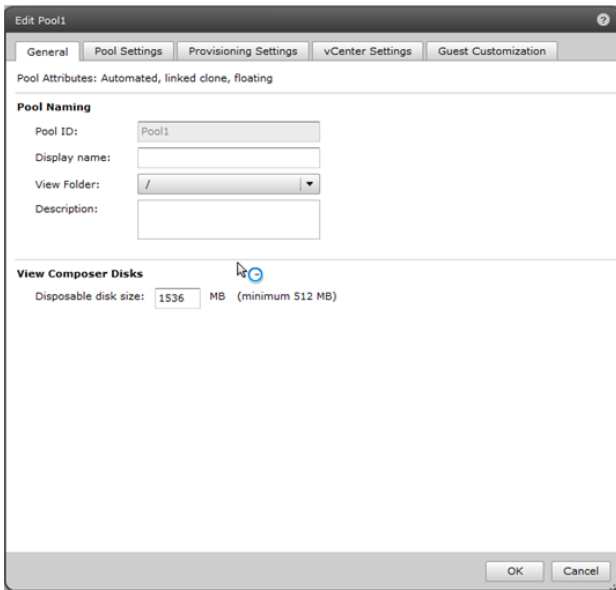
Server

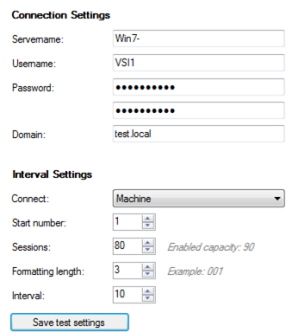
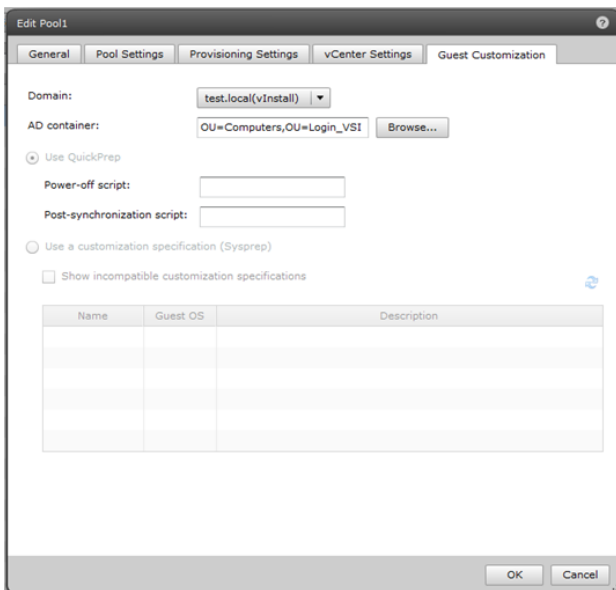
Allgemein	Ressourcen
Hersteller: FUJITSU	CPU-Nutzung: 2059 MHz
Modell: PRIMERGY 18301 S8	Kapazität: 12 x 3,946 GByte
CPU-Vorteil: 12 CPU x 3,946 GHz	Arbeitsspeicherumgebung: 133445,00 MB
Prozessor-Typ: Intel(R) Xeon(R) CPU E5-2680 v2 @ 2,60 GHz	Arbeitsspeicher: 24746,40 MB
Leistungs	Druckspeicher
Prozessor-Sockel: 2	Druckspeicher: Normal
Prozessor-Instanz: 6	Druckspeicher: Normal
Logische Prozessoren: 24	Druckspeicher: Normal
Hyper-Threading: aktiv	Druckspeicher: Normal
Anzahl an Festplatten: 2	Netzwerk: Typ: 10
Zustand: Verbunden	Netzwerk: VM Network
virtuelle Maschinen und Vorlagen: 73	Standard-Switch-Netzwerk
Whisker aktiviert: Nein	
VMware EVC-Modus: Dualhost	
Host für die Failover-Verwaltung konfiguriert: Nein	
Aktive Aufgaben: 1	
Hostprofil: Nicht verfügbar	
Prüfung der Überwachung: Nicht verfügbar	
Statistik	Fehlerraten
Neue virtuelle Maschine	Fehlerraten: 2.0.1.0.0.0.0.0
Neuer Ressourcenpool	VM-Aktionen abbrechen
In den Wartungsmodus wechseln	Gesamtwerte der primären virtuellen Maschinen: --
Neue Vorlagen	Eingeschaltete primäre virtuelle Maschinen: --
Neue Vorlagen	Gesamtwerte der sekundären virtuellen Maschinen: --
	Eingeschaltete sekundäre virtuelle Maschinen: --
Alarme	

Desktop

Allgemein	
Gastbetriebssystem:	Microsoft Windows 7 (32-Bit)
VM-Version:	7
CPU:	1 vCPU
Arbeitsspeicher:	2048 MB
Arbeitsspeicher-Overhead:	118,00 MB
VMware Tools:	OK
IP-Adressen:	192.168.44.138
DNS-Name:	WIN7-039.test.local
EVC-Modus:	Nicht verfügbar
Zustand:	Eingeschaltet
Host:	192.168.44.10
Aktive Aufgaben:	

Create 70 virtual machines based on W7Template and View Composer for deployment, whereby replica is configured on SSD data store and everything else on SAS data store (floating users).

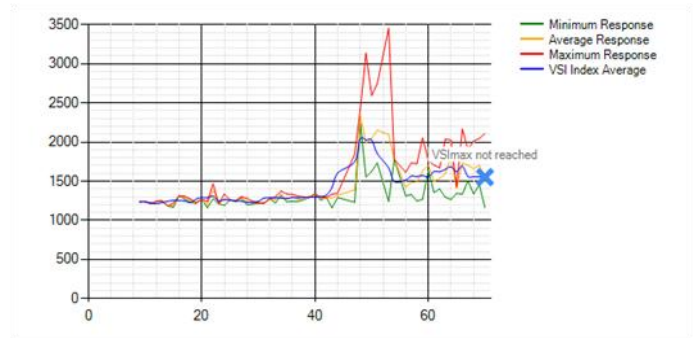




VSI Login Analyser

Analysis of the test result using VSI Login Analyser:

Evaluation type: Dynamic



Test result:

Replica on SSD, everything else on SAS data store.
Time required for completion: ~40 minutes.

Reconfiguration of the VSI Login Test

All launchers rebooted. All virtual machines rebooted.

Launchers

Launcher name	Enabled	Capacity
1. Launch1	Enabled	30
2. Launch2	Enabled	30
3. Launch3	Enabled	30

Test Configuration

Launcher Settings

Workload:

Workload mashup:

Launcher Settings

Auto start launcher:

Launch type:

Reset locked sessions:

Auto logoff:

Auto logoff timeout:

Create profiles:

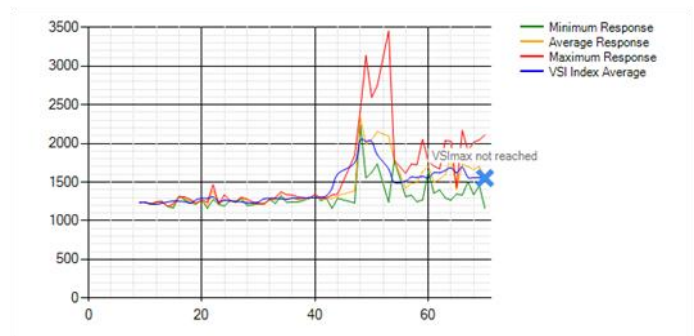
Connection type:

Custom Commandline

Specify Custom Commandline:

Specify CSV File:

Evaluation type: Classic



After having analyzed the results, delete the virtual machines on the SSD data store.

The non-attainment of VSIMax indicates that the results remain within the same range as with the test "replica and linked clones" which scaled up to 76 VMs as VSIMax.

Technical conclusion

The use of SSD drives for local caching with pooled desktops can - on account of the higher throughput - significantly improve the density of VMs on the hypervisor as well as the user experience of individual VMs.

It was also noticed (but not measured) that SSD drives handle the boot storm significantly better than the SAS disks, again on account of the higher I/O.

Technical limitations

During the proof-of-concept with SSD, 144 GB of main memory size turned out to be the limit. More than 75 workloads would have been theoretically possible with a larger memory size; then however we would have had to use the much more expensive 16 GB modules, which is not advisable from a price / performance perspective. Also by assuming less RAM per VM higher densities could have been achieved.

We decided deliberately against memory over-subscription / over-commitment as this means higher swap requirements on the SSDs.

In the test with conventional disks, I/O performance proved to be the limit. The maximum number of workloads was 31; additional memory did not improve the situation.

I/O considerations

The determined workloads and required disk space was checked for plausibility when using linked clones using a sizing guideline from VMware. The following tables were available:

Disk type	Size	Possible IOPS (mixed read / write)
15K RPM FC	146GB or 300GB	150
10K RPM FC	146GB or 300GB	125
SSD	160GB or 320GB	> 5,000

Attributes	Required IOPS
VMs per data store	250
IOPS per VM (normal user)	10
IOPS per VM (heavy user)	15
Total IOPS (70% normal / 30% heavy users, or 175 normal / 75 heavy users)	175 x 10 + 75 x 15 = 1750 + 1125 = 2875

With 75 normal users, 750 IOPS are needed. An SSD providing more than 5000 IOPS can easily meet this requirement. Two conventional RAID-1 disks with 15K rpm stop at 150 IOPS. More IOPS can only be provided, if you use RAID systems with a higher number of spindles.

Price comparison

As the basis for a cost comparison, the EURO list prices of the June 2011 price list were used. As the software was identical in both cases, it was completely ignored.

Configuration sheet with conventional disks

S26361-K1344-V301	PY RX300S6 12x2.5 gold SV	1	1.475,00 €	1.475 €
S26361-F3619-E266	Intel Xeon X5650 6C/12T 2.66 GHz 12 MB	2	1.250,00 €	2.500 €
S26361-F3604-E515	8 GB DDR3 1333 MHz PC3-10600 rg d	18	255,00 €	4.590 €
S26361-F4482-E130	HD SAS 6G 300GB 10K HOT PL 2.5" EP	2	210,00 €	420 €
S26361-F3554-E512	RAID Ctrl SAS 6G 5/6 512MB (D2616)	1	385,00 €	385 €
S26361-F2735-E7	Cable management for 19" PC rack	1	30,00 €	30 €
S26361-F2735-E101	RMK-F1_1-2U Server	1	55,00 €	55 €
Total price				9.455 €

Configuration sheet with SSD disks

S26361-K1344-V301	PY RX300S6 12x2.5 gold SV	1	1.475,00 €	1.475 €
S26361-F3619-E266	Intel Xeon X5650 6C/12T 2.66 GHz 12 MB	2	1.250,00 €	2.500 €
S26361-F3604-E515	8 GB DDR3 1333 MHz PC3-10600 rg d	18	255,00 €	4.590 €
S26361-F3298-E64	SSD SATA 3G 64GB SLC HOT PLUG 2.5" EP	4	1.130,00 €	4.520 €
S26361-F3554-E512	RAID Ctrl SAS 6G 5/6 512MB (D2616)	1	385,00 €	385 €
S26361-F2735-E7	Cable management for 19" PC rack	1	30,00 €	30 €
S26361-F2735-E101	RMK-F1_1-2U Server	1	55,00 €	55 €
Total price				13.555 €

Important note:

The test was performed with the new SSD which should be included in the System Architect as of October 2011. However, in order to make a price statement already at the time of the proof-of-concept, the prices of the two 100 GB SSD disks are shown with those of the available 64 GB disks. To be fair, the price of the conventional 300 GB disk was also adapted, because the disk utilization was identical; although no 146 GB disk as the smallest size was available.

To determine the hardware cost per workload, the server costs were divided by the number of workloads.

- Solid State Disk €181
- Traditional Disk €305

These results show a clear price advantage of using SSD, irrespective of the technical advantages (e.g. six times lower deployment outlay), which could also be regarded as a cost advantage. Then the advantages of SSDs become even more obvious.

The results determined here, are certainly a valuable basis for the design of a virtual desktop infrastructure. However, they should not be generally transferred to any other situation without further ado. It is always recommendable to check the real-life situation in detail including all aspects influencing operational costs.

Price outlook

According to analysts' opinions and our own estimations, the price of SSDs will decrease by between 15 and 20% within the next year so that SSDs are now becoming an ever-increasing implementation reality.

SSD capacities

In our scenario, we had gained the most from the SSD configuration, even including a reserve. More users would mean more or larger SSD disks. In this situation, when using double the disk capacity, the hardware costs would equal €241 per VM, which is still more efficient than conventional disks.

This important and sensitive topic regarding SSD prices means, we have also considered whether we could have used the cheaper SATA SSD disks instead of SAS SSD disks. We have looked at the I/O log files and determined that there had been a very high number of bursts which had been cleanly accepted by the SAS SSD. A SATA SSD would not have done so and would thus have generated short-term bottlenecks. The maximum number of write cycles to a memory cell is evident when viewing the datasheets and comparing SATA and SAS SSD. This is notably lower with SATA SSD which also explains the price. We thus recommend the more expensive SAS SSDs and advice against the cheaper SATA SSDs.

Storage sizing for local SSD data stores

Our collection of data impressively shows that local SSD data stores are a high performance and attractively priced alternative to shared storage or local data stores with classic hard disks.

Linked clones are the choice in this selection. All the changes concerning the replica disk are written during a user session to a delta file which constantly increases in size. However, as the delta file is deleted when logging off, only small file sizes have to be calculated. The next user of the virtual desktop still receives a "fresh" system.

For the storage sizing we consider server-based profiles, but no user data. The size of the Windows 7 template is assumed to be 30 GB, with a 2 GB RAM per VM.

A fundamental decision is required concerning the storage location of the swap file of the virtual machine. This is stored per default in the VM folder. These results, with 2 GB RAM without reservation, in a swap file size of 2 GB per VM.

If another data store with normal hard disks is available in the server, this swap file can be relocated, which considerably reduces memory requirements for SSD data stores.

If shared storage is also available in the environment, the swap files can be relocated there. Shared storage simplifies the storage of templates which all ESX servers can then centrally access.

SSD storage capacity (pure SSD data store:)

Storage capacity = (number of VMs * (delta size + swap + log) + replica * + template + overhead)

SSD with relocated swap files

Storage capacity = (number of VMs * (delta size + log) + replica * + template + overhead)

SSD storage capacity with relocated swap files and templates

Storage capacity = (number of VMs * (delta size + log) + replica * + overhead)

* The replica VM is created per data store as a clone of the "golden" template

Summary of the results

	Hard disks	SSD
Deployment of 120 VMs	210 min	35 min
Maximum number of VMs	31	75
Hardware costs per VM	€305	€181

With a scenario with identical workloads where a master is replicated by linking via View Composer, SSDs make sense if the architecture has a block structure with local disks. With an external storage system, the I/O performance can be much better, but network connection capacities must be taken into account. This paper does not attempt to make general architecture recommendations, but simply to provide suggestions. Numerous options are available regarding the location choice for data, images and swap area, and more.

Contact

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