Flash back to reality – Myths and Realities
SSD Industry trends perspectives and tips

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Introduction

Who is Greg Schulz, contact and other information

Has been IT Customer
Application systems development
Systems programming/management
Performance and Capacity Planning
Data Protection/Backup/BC/DR
Electric Power, Financial, Transportation

Has been Vendor
Storage, Network, SSD, Disk & Tape
Backup/BC/DR, RAID, Replication
NAS, SAN, LAN, MAN and WAN
Hardware, Software & Services
Sales Engineering, Tech Marketing

Industry Analyst/Advisor
Cloud, virtualization/VDI, servers,
HW, SW, servers, software defined,
services, archive, backup/BC/DR,
performance/capacity planning
Five time VMware vExpert
StorageIO.com

Author and Consultant
Syndicated columnist & blogger
StorageIOblog.com & StorageIO.TV

www.storageio.com/downloads

Twitter @storageio | Facebook.com/storageio | Storageioblog.com | storageio.com/newsletter
Industry Trends: SSD Walking the Talk
My experiences with SSD, spanning a “few” decades ;)

✓ Launch customer for DEC ESE20 ram based SSD (late 80s, early 90s)
✓ As a vendor sold various SSD solutions across various industry’s
✓ As a vendor also partnered with SSD providers to provide connectivity
  • Now I cover them from an analyst/advisor/consult basis
  • This means using them, researching them and other things
  • I have a mix of flash, RAM SSD in various packages
  • Enterprise and consumer class devices
  • From laptop to servers, not to mention phones, USB thumb drives
  • These get used in physical, virtual and I even use cloud SSDs
  • Workloads: database (little data) to Hadoop (big data) to exchange & others
  • Not to mention vdbench, iorate and others even when needed iometer ;)

Performance
Tool Box
Hardware
Software Tools
And
Techniques
Industry Trends: SSD yesterday & today
For some DejaVu, for others revolutionary, or “technolutionary”

Long list of past (DEC, HP, Imperial, Memorex, Quantum, Solid Data and others), current and emerging vendors. Some will survive on their own, some will be acquired, some will end up on the future “Where are they now list”

Reality (Today) = Hybrid Home Run
Hybrid can be mix of:
- Legacy storage and AFA
- HDD and SSD in system
- HHDD and SSHD
- Local and cloud storage
- Block, file and object
- DRAM, flash and magnetic
- New and old items
- How you use it all…

Reality (someday in the future)
Future Hybrid may be mix of:
- DRAM, flash and their successors
- Perhaps even some legacy magnetic
- Some using in old ways
- Some using in new ways
Industry Trends: Taking a step back
What’s your objective? Solve problem, find problem to solve?

Step or pull back so you have a better view of the big picture

What are you trying to accomplish, address, enable or verify? Is what you are doing relevant to your needs or simply what somebody else does, says or recommends?

High capacity, low cost bulk? Small low-latency high-priority?
All or nothing vs. hybrid (e.g. mix of what’s best for your needs)
### Industry Trends: Context - IOPs per device?

How many IOPs can a device do? What's the context?

<table>
<thead>
<tr>
<th>Device</th>
<th>Vendor</th>
<th>Make</th>
<th>Model</th>
<th>Form Factor</th>
<th>Capacity</th>
<th>Interface</th>
<th>RPM Speed</th>
<th>Raw Test Result</th>
<th>Test Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDD</td>
<td>HGST</td>
<td>Desktop</td>
<td>HK250-160</td>
<td>2.5</td>
<td>160GB</td>
<td>SATA</td>
<td>5.4K</td>
<td>Here</td>
<td>Soon</td>
</tr>
<tr>
<td>HDD</td>
<td>Fujitsu</td>
<td>Desktop</td>
<td>MHWZ160BH</td>
<td>2.5</td>
<td>160GB</td>
<td>SATA</td>
<td>7.2K</td>
<td>Here</td>
<td>Soon</td>
</tr>
<tr>
<td>HDD</td>
<td>WD/Dell</td>
<td>Enterprise</td>
<td>WD1003FBYX</td>
<td>3.5</td>
<td>1TB</td>
<td>SAS</td>
<td>7.2K</td>
<td>Here</td>
<td>Soon</td>
</tr>
<tr>
<td>HDD</td>
<td>Seagate</td>
<td>Momentus</td>
<td>ST9160823AS</td>
<td>2.5</td>
<td>160GB</td>
<td>SATA</td>
<td>7.2K</td>
<td>Here</td>
<td>Soon</td>
</tr>
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<td>HDD</td>
<td>Seagate</td>
<td>MomentusXT</td>
<td>ST95005620AS</td>
<td>2.5</td>
<td>500GB</td>
<td>SATA</td>
<td>7.2K(1)</td>
<td>Here</td>
<td>Soon</td>
</tr>
<tr>
<td>HDD</td>
<td>Seagate</td>
<td>Savio 10K.3</td>
<td>ST93006035S</td>
<td>2.5</td>
<td>300GB</td>
<td>SAS</td>
<td>10K</td>
<td>Here</td>
<td>Soon</td>
</tr>
<tr>
<td>HDD</td>
<td>Seagate</td>
<td>Savio 15K.2</td>
<td>ST91468525S</td>
<td>2.5</td>
<td>146GB</td>
<td>SAS</td>
<td>15K</td>
<td>Here</td>
<td>Soon</td>
</tr>
<tr>
<td>HDD</td>
<td>Seagate</td>
<td>Barracuda</td>
<td>ST3700MM01</td>
<td>3.5</td>
<td>3TB</td>
<td>SATA</td>
<td>7.2K</td>
<td>Here</td>
<td>Soon</td>
</tr>
<tr>
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<td>Barracuda</td>
<td>ST5050320AS</td>
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<td>500GB</td>
<td>SATA</td>
<td>7.2K</td>
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<td>146GB</td>
<td>SAS</td>
<td>15K</td>
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<td>Soon</td>
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<td>SSD</td>
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<td>Ent. Turbo</td>
<td>ST600MX0004</td>
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<td>600GB</td>
<td>SAS</td>
<td>SSD</td>
<td>Here</td>
<td>Soon</td>
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<tr>
<td>SSD</td>
<td>Seagate</td>
<td>Ent. 15K</td>
<td>ST000MM003</td>
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<td>600GB</td>
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<td>15K</td>
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<td>Soon</td>
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<td>SSD</td>
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<td>ST120FP0021</td>
<td>2.5</td>
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<td>SSD</td>
<td>Soon</td>
<td>Soon</td>
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<td>2.5</td>
<td>400GB</td>
<td>SAS</td>
<td>12GAS</td>
<td>SSD</td>
<td>Soon</td>
</tr>
<tr>
<td>SSD</td>
<td>Samsung</td>
<td>840 Pro</td>
<td>MZ-7PD256</td>
<td>2.5</td>
<td>256GB</td>
<td>SATA</td>
<td>SSD</td>
<td>Soon</td>
<td>Soon</td>
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<td>Desktop</td>
<td>ST4000DM00</td>
<td>3.5</td>
<td>4TB</td>
<td>SATA</td>
<td>HDD</td>
<td>Here</td>
<td>Soon</td>
</tr>
</tbody>
</table>

**Workload Pattern of test**

<table>
<thead>
<tr>
<th>Avg. Resp (R+W) ms</th>
<th>Avg. IOP Sec (R+W)</th>
<th>Bandwidth KB (R+W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% Seq 100% Read</td>
<td>0.1</td>
<td>7,658</td>
</tr>
<tr>
<td>60% Seq 100% Read</td>
<td>4.7</td>
<td>210</td>
</tr>
<tr>
<td>30% Seq 100% Read</td>
<td>7.7</td>
<td>130</td>
</tr>
<tr>
<td>0% Seq 100% Read</td>
<td>10.1</td>
<td>98</td>
</tr>
<tr>
<td>100% Seq 60% Read</td>
<td>3.5</td>
<td>282</td>
</tr>
<tr>
<td>60% Seq 60% Read</td>
<td>7.7</td>
<td>130</td>
</tr>
<tr>
<td>30% Seq 60% Read</td>
<td>9.3</td>
<td>107</td>
</tr>
<tr>
<td>0% Seq 60% Read</td>
<td>11.1</td>
<td>90</td>
</tr>
<tr>
<td>100% Seq 30% Read</td>
<td>6.0</td>
<td>105</td>
</tr>
<tr>
<td>60% Seq 30% Read</td>
<td>9.2</td>
<td>100</td>
</tr>
<tr>
<td>30% Seq 30% Read</td>
<td>11.0</td>
<td>90</td>
</tr>
<tr>
<td>0% Seq 30% Read</td>
<td>11.7</td>
<td>85</td>
</tr>
<tr>
<td>100% Seq 0% Read</td>
<td>8.5</td>
<td>117</td>
</tr>
<tr>
<td>60% Seq 0% Read</td>
<td>10.9</td>
<td>92</td>
</tr>
<tr>
<td>30% Seq 0% Read</td>
<td>11.8</td>
<td>84</td>
</tr>
<tr>
<td>0% Seq 0% Read</td>
<td>12.2</td>
<td>81</td>
</tr>
</tbody>
</table>

**Performance characteristics 1 worker (thread count) for RAW IO (non-file system)**

- Dell/Western Digital (WD) 1TB 7200 RPM SATA HDD (Raw IO) thread count 1 16K IO size

Industry Trends: Where’s the Problem?

Lead with the solution (or cure) before ailment is known?

Where are the bottlenecks/problems?

- Applications, Database, File systems
- OS, Hypervisor, Drivers, Configuration
- CPU, Memory, PCIe, Adapters
- Connectivity, Enclosures, Controllers

Where to find, then fix problem…

- Insight, awareness, baseline

Vs.

Move and mask the problem
Or have a solution looking for problem ;)

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Industry Trends: Server and Storage I/O
Some fundamentals and common sense around flash & SSD

✓ This is not an all or nothing, one size fits all value proposition
✓ Memory is storage and storage is persistent memory
  • The best I/O is the one you don’t have to do
  • The second best I/O is the one with least overhead
  • The importance of locality of reference
✓ Cache and SSD is like real-estate, location matters and impacts cost
  • A little bit of cache (RAM, flash, etc.) in the right place goes a long way
  • A lot of cache (RAM, flash, etc.) should have a benefit yet cost cash
✓ Just because something is new doesn’t mean its better or faster
✓ Fast applications need fast servers (and software), drivers, adapters, I/O paths, storage systems and devices

Can we get a side of context with them IOPS and other storage metrics?
http://storageioblog.com/side-context-iops/
Industry Trends: Locality of Reference
Memory is storage, storage is persistent memory

Servers (aka computers)
- Processor core(s) L1/L2/L3 cache
- Processors memory map
- Direct address range e.g. 16/32/64 bit

External memory (storage)
- Utilize file system
- DAS, SAN, NAS
- Block, file
- Objects

Flash SSD
- Faster, more expensive
- Generally non persistent
- O.S. Virtual & physical
- Memory map/range

Internal, external, dedicated, shared
- Networked, local, remote, cloud

Locality of reference

Source: StorageIOblog.com

Can we get a side of context with them IOPS and other storage metrics
http://storageioblog.com/side-context-iops
Industry Trends: SSD and flash myths
Some common SSD / flash related myths and realities

• Myth: SSD and flash are new
  o DRAM SSD has been around for decades
  o Flash is now over 20 years old

• Myth: Only All Flash Arrays (AFAs) can deliver performance
  o Not necessarily true, particular if not a good implementation

• Myth: Only “new” AFAs from startups can deliver performance
  o Care to guess who likes to keep this myth going? ;)
  o Some existing legacy systems will not benefit from flash or SSD
  o Some existing legacy systems greatly benefit from flash or SSD
  o Some systems have been back-end device starved (e.g. not controller)

• Myth: SSD too is expensive
  o This is true if compared on cost per space capacity
  o This is false if you compare on cost per work done (IOP, transaction, etc)
• Myth: Flash SSD does not consume power or generate heat
  o This is true when they are powered off
  o However they can run cooler than some HDDs
• Myth: Flash SSD does not break or wear out like HDD or tape
  o The flash cells do wear our from program/erase (p/e) cycles
  o Hence look at wear or durability, new metric such as TBytes/Written (TBW)
  o Also look for solutions that manage the wear, write gathering, optimization
  o Btw, also if benchmarking, “condition” them before use to avoid surprises
• Myth: Flash SSD wears out and will cause data loss
  o True however like other media, you can manage and plan accordingly
  o Don’t be scared of them or of some of the fud such as power loss (data loss)
• Myth: Flash SSD needs to replace HDDs
  o True for some applications and some vendors

www.storageio.com/ssd
Industry Trends: SSD and flash myths
Some common SSD / flash related myths and realities

• Myth: Flash SSD will magically fix all your data center issues
  o With the right amount of budget, perhaps…
  o However watch out for moving problems or bottlenecks elsewhere

• Myth: Flash SSD is all about more IOPs
  o We need more context around IOPs, IOPs without context are BS
  o However more than IOPs, also bandwidth, latency, reads, writes etc.
  o Also, what’s the system/server CPU and other impact when doing work

• Myth: Flash SSD eliminate need for performance and capacity planning
  o Hope you have a large bank account ;)

• Myth: Flash SSD cannot be used for backup/data protection
  o Why not, it’s a great way to speed up snaps, copies, catalog and other things
  o However vendors and their pundits don’t know how to tell the story
  o Its not in the play-book yet ;)

Can we get a side of context with them IOPS and other storage metrics
http://storageioblog.com/side-context-iops
Industry Trends: SSD and flash myths
Some common SSD / flash related myths and realities

- Myth: SSD in the cloud is magical or won't work
  - First, if your application is in the cloud, SSD can be good.
  - However, if your application is remote, keep response time in mind.
  - Also, there are different types of cloud SSD, understand the type of service.
  - For example, there are AWS EBS SSD backed volumes and IOP limits.
  - Then there are AWS EC2 high-io instances (servers with SSD).
  - What do you need, what are you trying to do, understand measurements.
  - For example, what is the cost per capacity of the service.
  - What are the IOP limits or constraints, also what size IOPs are used for billing.
  - Will the IOPs be deterministic or variable, yes they can vary by service.
  - This gets back to basic performance engineering and capacity planning.

www.storageio.com/ssd
Industry Trends: Where’s the Problem?
Lead with the solution (or cure) before ailment is known?

Re-iterate – What’s the focus and problem so we can solve or address

Where are the bottlenecks/problems?
- Applications, Database, File systems
- OS, Hypervisor, Drivers, Configuration
- CPU, Memory, PCIe, Adapters
- Connectivity, Enclosures, Controllers

Where to find, then fix problem…
- Insight, awareness, baseline

Vs.

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Or have a solution looking for problem ;)

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Where to use SSD?
SSD as cache, target or hybrid, which is right or best for you?

Answer: It depends on your needs, budget and preferences!

- SSD drive in server
- PCIe card as a cache
- PCIe card as a target
- SSD drive in appliance
- PCIe card in appliance
- SSD drive in storage system along with HDDs
- SSD cache appliance
- SSD drive in workstation or laptop

www.storageio.com/ssd
Industry Trends: Storage I/O tools
What’s in your toolbox, what to use for different things?

• Insight and awareness
  o OS tools (e.g. Perfmon etc), 3rd party (Spotlight on Windows/*nix), etc.
  o VM tools (ESXTOP, Visual ESXTOP) and storage system based
  o Others including HiMon (e.g. from HyperIO)
  o Database tools (e.g. Microsoft SQL Server Studio and others)

• Workload generators (benchmarks etc.)
  o The best = Your application under real or applicable workloads!
  o Second best = Variation of your application under realistic workloads
  o Synthetic that span application software, server, storage and I/O paths
  o Traces or sub-system or component specific tools
  o Some examples include among others
    Benchmark Factory, Dedisbench, DFSIO (Hadoop), Fio, Hammer, Iometer, Iorate, 
    Iozone, Jet, Login VSI, PCMark, SNIA Emerald (uses vdbench), SPEC, SQLIO, 
    Tera (Teragen, Terasort, Teravalidate for Hadoop), TPC, Vdbench, VMmark (based 
    on DVD Store) and many others.

http://storageioblog.com/iops-hdd-hhdd-ssd-vmware/
Focus: Guests OS

Focus area: Performance, availability, resource usage?

Tools Not In A Specific Order Below!

- Plugins
- I/O Cache Tools
- Accelerators
- Path Managers
- Drivers

Business Applications

Database / Key Value Repositories

File system

Volume Manager

Operating System

Hypervisors

Hardware

Local, Metro Wide Area
Focus: Hypervisors

Focus area: Applications, CPU, Memory, Storage I/O network?

Some tools include Citrix, Dell, JAM, Login VSI, Microsoft, RV Tools, Solarwinds, Spacesniffer, Visual ESX top and VMware among many others.
Focus: Hypervisors

Focus area: Applications, CPU, Memory, Storage I/O network?

- Applications
  - SAP, Exchange, other App centric & 3rd party
  - Dell (Toad), Oracle, Microsoft and other tools
- Databases
- File systems
- Guest OS / Drivers
  - Microsoft, *nix and 3rd parties, SOW, SO*nix, etc

Hypervisor and drivers

- ESX Storage Stack
  - Drivers
  - Physical Adapters
  - (Optional Network)
- Storage System/Device

Visual ESXtop and others

- GAVG = Guest avg. resp. time
- KAVG = Time in vmkernel
- QAVG = Time in vStorage stack
- DAVG = Device time (w/o OS or vmw)
Focus: Hypervisors and Cache
Focus area: Cache Tools and Technologies

Tools Not In A Specific Order Below!
- Business Applications
- Database / Key Value Repositories
- File system
- Volume Manager
- Operating System
- Hypervisors
- I/O Cache Tools
- Accelerators
- Path Managers
- Drivers

Local, Metro Wide Area

VirtunetSystems VirtuCache

Companion Material
Focus: Storage Performance

Focus area: Server and Storage IO performance

Tools Not In A Specific Order Below!

- Business Applications
- Database / Key Value Repositories
- File system Volume Manager
- Operating System
- Hypervisors
- Hardware

Part II: How many IOPS can a HDD, HHDD or SSD do with VMware?


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Industry Trends: vdbench example
Server and Storage I/O metrics and context, more than just IOPs

15:23:06.971 Starting RD=write000nseq510V; I/O rate: Uncontrolled MAX; elapsed=120; For Loops: xfersize=10m

15:25:08.010 Starting RD=write000nseq510V; I/O rate: Uncontrolled MAX; elapsed=120; For Loops: xfersize=4M

Warning: total amount of i/o per second per slave (116696) greater than 50000.
15:27:08.031 * You may need to adjust your total slave count (see 'vms=' in documentation).
15:27:08.031 * This run actively used 1 slaves.

Vdbench “manifest”
Of output
Summary
Detail, logs
Histograms
Industry Trends: vdbench jumpstart
Some quick start, hints and tips

Download vdbench from Oracle

Create a folder of where to copy the download into

Code and examples for different OS and other items
Install Java 7u55 (or later) - http://java.com/en/download/chrome.jsp?locale=en

Add Java environment settings (if applicable, e.g. Windows)

JAVA_HOME
C:\Program Files (x86)\Java\jre7\bin;

Path
;C:\Program Files (x86)\Java\jre7\bin;

For Windows servers you may need reset performance counters
Via command (with admin rights) Lodctr /R

Read the vdbench documentation...
Industry Trends: vdbench example

Example script for exercising workload

Some examples:
SNIA Emerial on-line active disk “hot-band” workload

http://www.snia.org/emerald/download

Or another script example

* Sample command line
*  
* vdbench -f SIO_vdbench_basic.txt devnum=1 devsize=5g devname=X1TMPFILE worktbd=4k,10m etime=120 itime=30 -o 061814_BasicX1
*  
* sd=sd1,lun=\\\PHYSICALDRIVE!devnum,size=!devsize,offset=512,thread=16

sd=sd1,\\c:\\temp\vdbenchJun182014.tmp,size=!devsize,offset=512,thread=16

*  
* sd=sd2,lun=\\\PHYSICALDRIVE2,size=370g,offset=512

Industry Trends: vdbench example
Example script for exercising workload

* Define the workloads:

```
wd=write100seqSIOV,sd=(sd1),seekpct=seq,rdpct=0
wd=write075seqSIOV,sd=(sd1),seekpct=seq,rdpct=25
wd=write050seqSIOV,sd=(sd1),seekpct=seq,rdpct=50
wd=write025seqSIOV,sd=(sd1),seekpct=seq,rdpct=75
wd=write010seqSIOV,sd=(sd1),seekpct=seq,rdpct=90
wd=write000seqSIOV,sd=(sd1),seekpct=seq,rdpct=100

wd=write100ranSIOV,sd=(sd1),seekpct=100,rdpct=0
wd=write075ranSIOV,sd=(sd1),seekpct=100,rdpct=25
wd=write050ranSIOV,sd=(sd1),seekpct=100,rdpct=50
wd=write025ranSIOV,sd=(sd1),seekpct=100,rdpct=75
wd=write010ranSIOV,sd=(sd1),seekpct=100,rdpct=90
wd=write000ranSIOV,sd=(sd1),seekpct=100,rdpct=100

wd=write050mixSIOV,sd=(sd1),seekpct=50,rdpct=50
```

[Companion Material](http://storageioblog.com/part-ii-iops-hdd-hhdd-ssd/)
Industry Trends: vdbench example
Example script for exercising workload

* Define the test steps
  *
  *rd=write050mixSIOV, wd=write050mixSIOV, elapsed=!etime, interval=!itime, iorate=max, forxfersize=(!worktbd), openflags=directio
  *
  *rd=write000seqSIOV, wd=write000seqSIOV, elapsed=!etime, interval=!itime, iorate=max, forxfersize=(!worktbd), openflags=directio
  *
  *rd=write010seqSIOV, wd=write010seqSIOV, elapsed=!etime, interval=!itime, iorate=max, forxfersize=(!worktbd), openflags=directio
  *
  *rd=write025seqSIOV, wd=write025seqSIOV, elapsed=!etime, interval=!itime, iorate=max, forxfersize=(!worktbd), openflags=directio
  *
  *rd=write050seqSIOV, wd=write050seqSIOV, elapsed=!etime, interval=!itime, iorate=max, forxfersize=(!worktbd), openflags=directio
  *
  *rd=write075seqSIOV, wd=write075seqSIOV, elapsed=!etime, interval=!itime, iorate=max, forxfersize=(!worktbd), openflags=directio
  *
  *rd=write100seqSIOV, wd=write100seqSIOV, elapsed=!etime, interval=!itime, iorate=max, forxfersize=(!worktbd), openflags=directio
  *
  *rd=write000ranSIOV, wd=write000ranSIOV, elapsed=!etime, interval=!itime, iorate=max, forxfersize=(!worktbd), openflags=directio
  *
  *rd=write010ranSIOV, wd=write010ranSIOV, elapsed=!etime, interval=!itime, iorate=max, forxfersize=(!worktbd), openflags=directio
  *
  *rd=write025ranSIOV, wd=write025ranSIOV, elapsed=!etime, interval=!itime, iorate=max, forxfersize=(!worktbd), openflags=directio
  *
  *rd=write050ranSIOV, wd=write050ranSIOV, elapsed=!etime, interval=!itime, iorate=max, forxfersize=(!worktbd), openflags=directio
  *
  *rd=write075ranSIOV, wd=write075ranSIOV, elapsed=!etime, interval=!itime, iorate=max, forxfersize=(!worktbd), openflags=directio
  *
  *rd=write100ranSIOV, wd=write100ranSIOV, elapsed=!etime, interval=!itime, iorate=max, forxfersize=(!worktbd), openflags=directio

SSD Cache Testing Configuration

Virtual and physical server config

Workload
Drivers

System(s) or
Solution under Test

Workload config
Duration, pre-amble
Conditioning
Streams/tasks
Size of data pool

Various
Guests
Guest VM

Win 7
Guest VM

VMware
Host (PM)

Exchange
Win Server 2011
Guest VM

SQL Server 2012
Windows 7
Guest VM

Win 7
Guest VM

Various
Guests
Guest VM

Various
Guests
Guest VM

Various
Guests
Guest VM

VMware
Host (PM)

VirtuCache
vSphere ESXi 5.5
VMware Host (PM)

vdisk

vdisk

12Gbs SAS

datastore

HDDs

SSD

vSphere ESXi version
Scaling factor
RDM or datastore config
Cache or non-cache
Queues and other params
PVSCSI or regular adapter

See more info and result examples at http://storageio.com/whitepaper.html
SSD Cache Testing Configuration
Virtual and physical server config

Pre-testing validation many VMs to PM

- Win 7
- Various Guests
- Exchange
- Win Server 2011
- SQL Server 2012
- Windows 7
- Guest VM
- Win 7
- Various Guests
- Guest VM
- vSphere ESXi 5.5
- VMware Host (PM)
- SQL Server 2012
- Windows 7
- Guest VM

Some tests have one VM to PM

- SQL Server 2012
- Windows 7
- Guest VM

Cache
vSphere ESXi 5.5
VMware Host (PM)

Dual-Quad Cores
2-3GHz
Various memory
PCIe Gen 3
Updated BIOS

HDDs
datastore
vdisk
SSD

12Gbs SAS
QDR IBA

Various adapters and devices, updated drivers, fw and bios

See more info and result examples at http://storageio.com/whitepaper.html
Industry Trends: Some proof points
Examples of what has been discussed here today

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Industry Trends: Some proof points
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Industry Trends: Some proof points
Examples of what has been discussed here today

TPC-E (OLTP Financial Workload)
Single Device Proof-Points

<table>
<thead>
<tr>
<th>Users</th>
<th>Transactions Per Second (TPS)</th>
<th>Response Time / Latency (Sec.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Work Being Done (More is Better)</td>
<td>Time Required To Do Work (Less is Better)</td>
</tr>
<tr>
<td>100</td>
<td>188.321</td>
<td>0.38</td>
</tr>
<tr>
<td>50</td>
<td>185.427</td>
<td>0.225</td>
</tr>
<tr>
<td>20</td>
<td>156.103</td>
<td>0.111</td>
</tr>
<tr>
<td>10</td>
<td>123.389</td>
<td>0.07</td>
</tr>
<tr>
<td>100</td>
<td>10.163</td>
<td>2.575</td>
</tr>
<tr>
<td>50</td>
<td>9.413</td>
<td>1.599</td>
</tr>
<tr>
<td>20</td>
<td>9.351</td>
<td>0.855</td>
</tr>
<tr>
<td>10</td>
<td>6.113</td>
<td>0.698</td>
</tr>
<tr>
<td>100</td>
<td>4.19</td>
<td>5.731</td>
</tr>
<tr>
<td>50</td>
<td>4.042</td>
<td>3.198</td>
</tr>
<tr>
<td>20</td>
<td>4.1</td>
<td>1.608</td>
</tr>
<tr>
<td>10</td>
<td>3.974</td>
<td>0.901</td>
</tr>
<tr>
<td>100</td>
<td>3.703</td>
<td>25.571</td>
</tr>
<tr>
<td>50</td>
<td>3.737</td>
<td>12.591</td>
</tr>
<tr>
<td>20</td>
<td>3.123</td>
<td>6.0</td>
</tr>
<tr>
<td>10</td>
<td>2.082</td>
<td>4.508</td>
</tr>
</tbody>
</table>

Logarithmic Scale Base 5

See more info and result examples at http://storageio.com/whitepaper.html

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SSD Cache Testing Configuration

Configuration

Applications
Operating System
Virtual Machines

Hypervisor
I/O Bottlenecks
Physical Machine

Virtual disks
Virtual datastores
Physical storage

See more info and result examples at http://storageio.com/whitepaper.html
SSD Cache Testing Configuration

Configuration

See more info and result examples at http://storageio.com/whitepaper.html
Industry Trends: Some proof points
Examples of what has been discussed here today

Mixed Concurrent Workloads (TPC-B, TPC-E and Exchange)
Cached and Non-Cached Device Proof-Points

Transactions Per Second (TPS)
Work Being Done (More is Better)

Response Time / Latency (Sec.)
Time Required To Do Work (Less is Better)

<table>
<thead>
<tr>
<th>Workload</th>
<th>Cached 6TB HDD</th>
<th>Non-Cached 6TB HDD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exchange</td>
<td>34.5</td>
<td>N/A</td>
</tr>
<tr>
<td>TPCB</td>
<td>52.6</td>
<td>0.6</td>
</tr>
<tr>
<td>TPCE</td>
<td>7.7</td>
<td>5.2</td>
</tr>
<tr>
<td>Exchange</td>
<td>8.0</td>
<td>N/A</td>
</tr>
<tr>
<td>TPCB</td>
<td>36.7</td>
<td>0.8</td>
</tr>
<tr>
<td>TPCE</td>
<td>6.5</td>
<td>6.4</td>
</tr>
</tbody>
</table>

Logarithmic Scale Base 5  
TPCE and TPCB = 50 Users

Source: StorageIO Labs

See more info and result examples at [http://storageio.com/whitepaper.html](http://storageio.com/whitepaper.html)

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Industry Trends: What about the cloud?
Good question, actually there are several things to consider…

✓ How will you be using SSD in the cloud, from within the cloud?
✓ Service providers are offering various SSD “backed” e.g. based services
✓ AWS, Microsoft/Azure, Rackspace, etc…
  o AWS has many different services including EBS, RDS, and EC2
  o For example most think cloud storage and EBS etc
  o However there are EC2 “high-io” instances with dedicated SSDs
  o With all services understand what IOP or bandwidth limits are in place
  o Also understand if the performance will be deterministic or variable (don’t assume)
  o Know how the IOPs are invoiced, for example a 32K IOP might count as two IOPs
  o Understand if there are any space capacity to IOP ratio or requirements
  o Most of the tools mentioned will work in various cloud environments ;)

http://storageioblog.com/cloud-conversations-aws-ebs-optimized-instances/
Industry Trends: Some tips
These may be obvious, however let’s state the obvious

✓ Know your applications, workloads and their characteristics
✓ Find and identify bottlenecks, avoid simply moving them, fix them
✓ A little cache (SSD, flash, DRAM) in the right place goes a long way
✓ Test with or use metrics that have context to your applications
✓ When testing, use your applications under load
✓ Or configure workloads to be realistic of your environments
✓ Configure system under test (SUT) to remember your environment
  • E.g. RAID, snapshots, replication, thin-provision, dedupe, compress, etc
  • Likewise are your servers and adapters faster enough
  • Pre-condition your storage before use to get realistic results

Can we get a side of context with them IOPS and other storage metrics?
http://storageioblog.com/side-context-iops/
Prepare and plan for your journey

• Have a vision, strategy and plan (e.g. an itinerary and road map)
• Fast servers and applications need fast storage and I/O networks
• Start using new (and old) technology in new ways removing complexity
• Reduce your data footprint impact (pack smartly for your journey)
• A little bit of flash or SSD or cache in the right place goes a long way
• A lot of flash or SSD will help, however it also will cost lots of cash

Where to learn more

• www.storageio.com (articles, videos & webcasts)
• www.storageioblog.com and twitter @storageio
• Check our other recent and upcoming events www.storageio.com/events
• Facebook.com/storageio and www.StorageIO.com/newsletter
• Feel free to call, IM, tweet, or email greg@storageio.com
Thank You

Flash back to reality – Myths and Realities
SSD Industry trends perspectives and tips

Presented by Greg Schulz, Founder & Sr. Advisory Analyst
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