

Using Oracle VDBench to Implement IDC All Flash Array Testing



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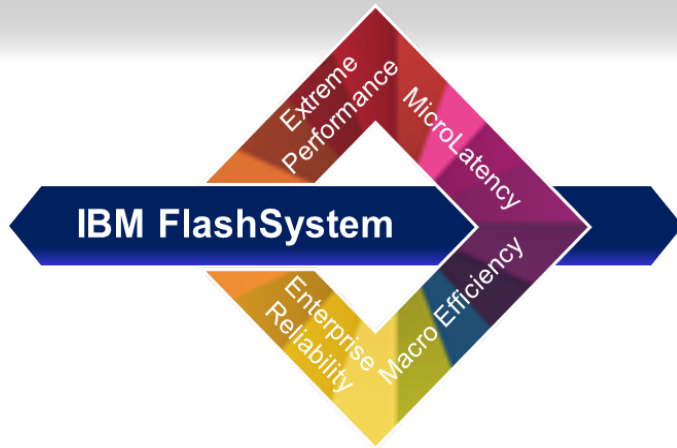
Agenda

- What is an AFA?
- What is VDBench?
- What is the IDC and why do we care?
- What are the suggested AFA tests?
- Implementing the IDC AFA tests with VDBench

What is an AFA?

- All-Flash-Array
- Not SSD (form-factor flash drives)
- Built from Function-designed flash modules
- Integrated control, configuration and monitoring
- IBM and Violin are two examples

FlashSystem 840 and V840



FlashSystem
addresses 2 primary market segmentations:

- **Absolute Performance**
for extreme performance of throughput, IO, and latency

- **Enterprise**
for full featured enterprise features sets married to flash performance



IBM FlashSystem 840



IBM FlashSystem Solutions

Macro Efficiency

- 2U form factor- minimal footprint for best of breed ROI
 - Low power 625 watts
- Field upgradeable, granular capacity
 - 4, 8, 12, 16, 20, 24, 32, 40, 48
- Reduce installation and management time with intuitive standardized GUI

Enterprise Reliability

- Fully redundant and hot swappable architecture:
 - Flash modules, power supplies, batteries, interfaces, fans
- Maintain business continuity with Concurrent code load
 - AES 256 HW base encryption

MicroLatency™

- Low Latency 135/90 μ s R/W
- Purpose-built, highly parallel design
- Maximize host CPU efficiency and productivity

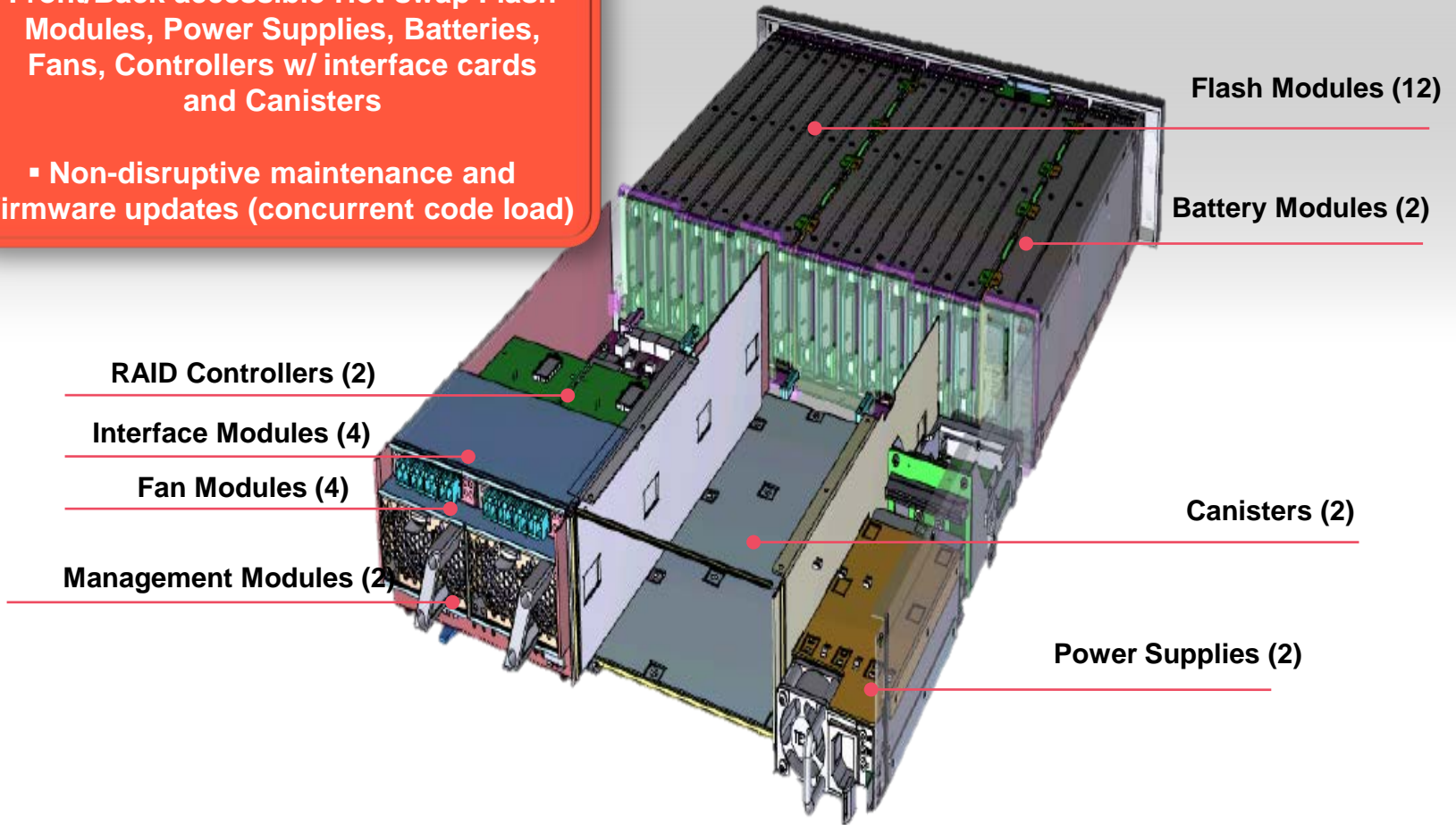
Extreme Performance

- 1.1M IOPS
- 8 GB/s Bandwidth
- Multiple connectivity interfaces
 - 16Gb/8Gb Fibre Channel
 - 40Gb QDR InfiniBand
 - 10Gb FCoE

IBM FlashSystem 840: Hardware View

Improved RAS Features

- Front/Back accessible Hot-swap Flash Modules, Power Supplies, Batteries, Fans, Controllers w/ interface cards and Canisters
- Non-disruptive maintenance and firmware updates (concurrent code load)



What is VDBench?

- Command line system
- Simulates various load scenarios including multiple hosts
- Doesn't require an Oracle install
- Scriptable
- Provided free from Oracle
- Vdbench has been tested on Solaris Sparc and x86, Windows NT, 2000, 2003, 2008, 2012, XP and Windows 7+8, HP/UX, AIX, Linux, Mac OS X, zLinux, and native VmWare
- Download from:

<http://www.oracle.com/technetwork/server-storage/vdbench-downloads-1901681.html>

VDBench Download Page

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Vdbench Downloads

Vdbench is a command line utility specifically created to help engineers and customers generate disk I/O workloads to be used for validating storage performance and storage data integrity. Vdbench execution parameters may also specified via an input text file.

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Vdbench (5.04.02)

[vdbench50402.zip](#)

- [User Guide](#)
- [Vdbench Discussion Forum](#)

Vdbench (5.04)

[vdbench50401.zip](#)

- [User Guide](#)
- [Vdbench Discussion Forum](#)

Related Downloads

- [Vdbench source code](#)

What is the IDC and why do we care?

- **International Data Corporation (IDC)** is the premier global provider of market intelligence, advisory services, and events for the information technology, telecommunications and consumer technology markets
- IDC helps IT professionals, business executives, and the investment community make fact-based decisions on technology purchases and business strategy
- More than 1,100 IDC analysts provide global, regional, and local expertise on technology and industry opportunities and trends in over 110 countries worldwide
- For 50 years, IDC has provided strategic insights to help our clients achieve their key business objectives
- IDC is a subsidiary of IDG, the world's leading technology media, research, and events company.
- IDC provides guidelines on standard tests to use in comparing computer technologies
- Located here:

<http://www.idc.com/home.jsp>

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Opinion and Trends

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- IDC MarketScape
- Black Book Daily

Analysis of the industry's hottest market trends in an easy-to-use, downloadable slide published daily.

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IDC and AFA

- IDC has provided a detailed test specification for AFA
- Using the IDC specification you can easily test and compare AFAs
- The public link for the IDC testing guidelines for AFAs is:

<http://idcdocserv.com/251951>

IDC Testing

In the universe of performance testing, there are five basic types of tests that could potentially be performed, and these are ranked in order of relevance to understanding how an array will perform on your actual production workload:

- **Class A:** Workload testing using your actual data streams, data sets, and workflows
- **Class B:** Workload testing using data streams, data sets, and workflows that are generated using application-specific testing tools like SLOB (Oracle), Jetstress (Exchange), Login VSI (VDI), and others
- **Class C:** Workload testing that uses data streams, data sets, and workflows generated by general-purpose workload generation tools like Load DynamiX, FIO, or vdbench that are capable of very accurate modeling
- **Class D:** An intelligent performance corners test using generic data sets, data streams, and workflows designed to closely model 3rd Platform computing workloads
- **Class E:** Hero testing that encompasses most classic performance corners testing

In AFA testing, IDC recommends Class D type tests

IDC Test Plan

AFA Test Plan Summary

Phase	Description	Tasks	Estimated Elapsed Time
1	Setup and preconditioning	2 x 85% overwrite	24 hours
	Data set preparation	2 x 5% overwrite 5 x 1% overwrite	6 hours
2	Baseline workload testing	Develop scripts	6 hours
		Thread/queue depth optimization	6 hours
		IOPS ramp testing (4 runs at 3 hours per run)	12 hours
3	Functional testing	Document workflows	6 hours
		Test workflows (4 runs at 4 hours per run)	16 hours
4	Fault injection testing	Inject failures (4 runs at 2 hours per run)	8 hours
5	Soak test	Run 4 baseline workloads consecutively(12 hours each)	48 hours
			132 hours

Source: IDC, 2014

Testing the IBM FlashSystem 840 40 TB System

- Preconditioning
 - 840 has 40 usable TB (39.06 TiB)
 - We already have extracted the “overhead” so we will configure the 39 into 39-1 TiB LUNS
 - Actual amount of flash is 52 TiB
 - Preconditioning volume of writes would be $52 * 0.85 * 2 = 88.4$ TiB
 - At 128K blocks the throughput for the 840 is 1.7 GB/s for a single Power8 server with 16 threads per LUN
 - 53,248 seconds to do writes (~15 hours)
 - Monitor for write cliff, if not reached at end of first run, repeat
- Data Set Preparation and Aging
 - 2 additional runs with small random writes (4-16kb) each at 5% of 52 TiB so 2.6 TiB each run randomly spread across system (3 runs of around 900 GiB one at 4k, 8k and 16k)
 - 5 additional runs with small random writes (4-16kb) each at 1% of 52 TiB (520 GiB) each run randomly spread across system (3 streams 4, 8 and 16k each doing 180 GiB each) each run addressing different sets of luns.

VDBench Scripting

- Utilizes tags for each script section
- SD for drive/storage designations
- WD for workload definitions
- RD for run definitions

Preconditioning Script

Create several luns, do 39-1.0 TiB size that used most of the 39.06 TiB.

Contents of precondition.cfg:

```
sd=default, openflags=o_direct  
sd=sd1,lun=\\.\PhysicalDrive1  
sd=sd2,lun=\\.\PhysicalDrive2  
sd=sd3,lun=\\.\PhysicalDrive3  
...  
sd=sd37,lun=\\.\PhysicalDrive37  
sd=sd38,lun=\\.\PhysicalDrive38  
sd=sd39,lun=\\.\PhysicalDrive39
```

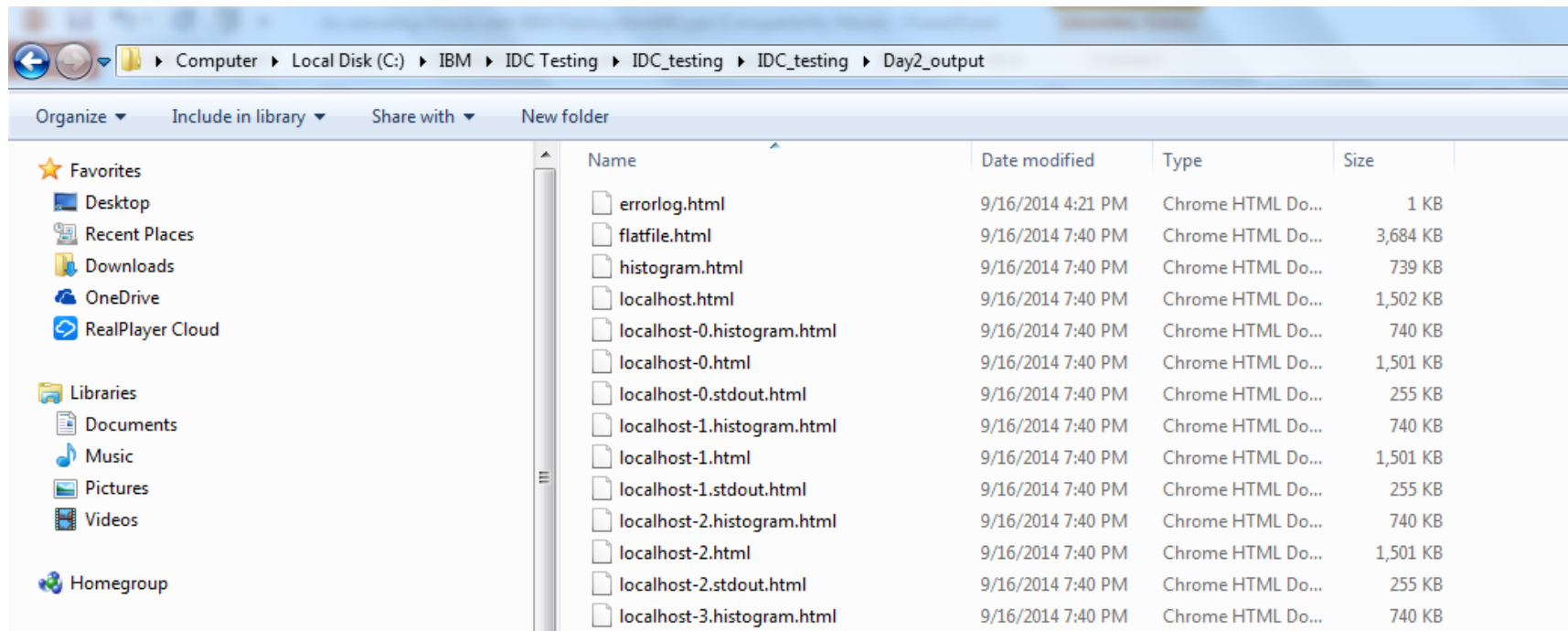
```
wd=fill,sd=sd*,rdpct=0,xfersize=128k,seekpct=-1  
rd=precondition,wd=fill,iorate=max,elapsed=54000,interval=30,threads=16
```

Running the Script

- Use the command line
- Specify output location if you want a specific location for the output HTML files

```
\vdbench\vdbench -f precondition.cfg -m 40 -o \vdbench\output\precon
```

Example Output Files



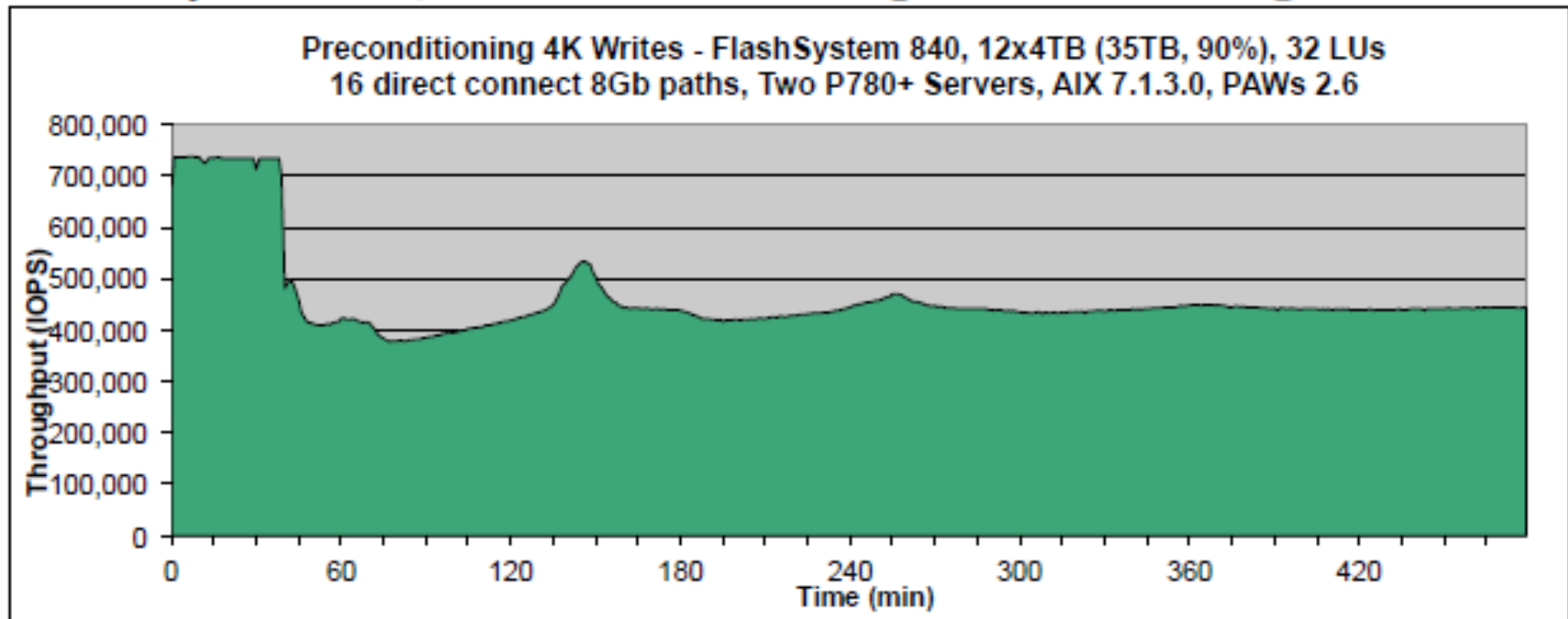
The screenshot shows a Windows File Explorer window with the address bar path: Computer > Local Disk (C:) > IBM > IDC Testing > IDC_testing > IDC_testing > Day2_output. The window displays a list of files in a table format. The left sidebar shows the navigation pane with Favorites, Libraries, and Homegroup sections. The main pane shows a list of files with columns for Name, Date modified, Type, and Size.

Name	Date modified	Type	Size
errorlog.html	9/16/2014 4:21 PM	Chrome HTML Do...	1 KB
flatfile.html	9/16/2014 7:40 PM	Chrome HTML Do...	3,684 KB
histogram.html	9/16/2014 7:40 PM	Chrome HTML Do...	739 KB
localhost.html	9/16/2014 7:40 PM	Chrome HTML Do...	1,502 KB
localhost-0.histogram.html	9/16/2014 7:40 PM	Chrome HTML Do...	740 KB
localhost-0.html	9/16/2014 7:40 PM	Chrome HTML Do...	1,501 KB
localhost-0.stdout.html	9/16/2014 7:40 PM	Chrome HTML Do...	255 KB
localhost-1.histogram.html	9/16/2014 7:40 PM	Chrome HTML Do...	740 KB
localhost-1.html	9/16/2014 7:40 PM	Chrome HTML Do...	1,501 KB
localhost-1.stdout.html	9/16/2014 7:40 PM	Chrome HTML Do...	255 KB
localhost-2.histogram.html	9/16/2014 7:40 PM	Chrome HTML Do...	740 KB
localhost-2.html	9/16/2014 7:40 PM	Chrome HTML Do...	1,501 KB
localhost-2.stdout.html	9/16/2014 7:40 PM	Chrome HTML Do...	255 KB
localhost-3.histogram.html	9/16/2014 7:40 PM	Chrome HTML Do...	740 KB

File Contents (Summary file)

Sep 16, 2014	interval	i/o rate	MB/sec 1024**2	bytes i/o	read pct	resp time	read resp	write resp	resp max	resp stddev	queue depth	cpu% sys+u	cpu% sys
16:19:08.058	1	74950.00	36.60	512	10.04	0.341	0.541	0.318	426.042	1.776	25.5	0.0	4.3
16:19:09.018	2	103950.00	50.76	512	10.01	0.258	0.437	0.238	6.256	0.257	26.8	8.2	6.4
16:19:10.016	3	118267.00	57.75	512	10.13	0.233	0.464	0.207	46.793	0.540	27.5	13.6	7.6
16:19:11.030	4	121366.00	59.26	512	9.88	0.230	0.471	0.204	195.091	0.932	27.9	12.1	8.2
16:19:12.020	5	110907.00	54.15	512	9.93	0.245	0.425	0.225	6.435	0.258	27.2	5.1	5.8
16:19:13.017	6	105364.00	51.45	512	9.99	0.261	0.427	0.243	7.380	0.248	27.5	8.3	5.4
16:19:14.016	7	125217.00	61.14	512	9.95	0.220	0.474	0.192	29.523	0.637	27.5	10.2	8.2
16:19:15.030	8	116730.00	57.00	512	10.10	0.239	0.486	0.212	149.333	0.830	27.9	12.5	7.8
16:19:16.018	9	117267.00	57.26	512	10.09	0.232	0.423	0.210	11.671	0.265	27.2	8.0	7.1
16:19:17.016	10	126531.00	61.78	512	10.01	0.218	0.462	0.190	16.961	0.605	27.5	10.4	7.5
16:19:18.002	11	111330.00	54.36	512	10.04	0.247	0.426	0.227	11.312	0.261	27.5	9.5	7.5
16:19:19.016	12	125546.00	61.30	512	10.15	0.219	0.471	0.191	62.544	0.619	27.5	12.8	8.6
16:19:20.017	13	108123.00	52.79	512	10.06	0.255	0.437	0.234	13.263	0.272	27.5	6.6	4.7
16:19:21.016	14	118485.00	57.85	512	10.03	0.233	0.459	0.207	16.959	0.565	27.6	10.2	7.4
16:19:22.030	15	127885.00	62.44	512	9.98	0.218	0.460	0.192	31.209	0.660	27.9	12.0	9.9
16:19:23.018	16	108483.00	52.97	512	9.99	0.251	0.449	0.229	301.127	0.958	27.2	7.7	5.8
16:19:24.016	17	108807.00	53.13	512	9.77	0.253	0.494	0.227	78.131	0.903	27.6	10.8	6.3
16:19:25.018	18	114688.00	56.00	512	9.96	0.240	0.423	0.220	9.425	0.248	27.5	9.0	6.7
16:19:26.016	19	116589.00	56.93	512	10.01	0.236	0.486	0.208	31.922	0.648	27.5	8.1	6.7
16:19:27.017	20	109109.00	53.28	512	9.98	0.252	0.429	0.233	13.926	0.265	27.5	11.8	6.0
16:19:28.016	21	123767.00	60.43	512	9.99	0.222	0.448	0.197	15.685	0.566	27.5	8.4	8.5
16:19:29.030	22	124040.00	60.57	512	9.90	0.225	0.479	0.197	112.039	0.749	27.9	13.2	8.7
16:19:30.018	23	113921.00	55.63	512	9.94	0.238	0.414	0.219	12.076	0.254	27.2	8.4	7.9

Write Cliff (Preconditioning is over)



Max write IOPS = 700+ K IOPS (sustained over 30+ mins)

Long-term write IOPS = 400+ K IOPS

Note that this long-term IO rate is consistent with the 100% write response time curve on the next page

Phase 1: Data Conditioning and Aging

- Conditioning is 2 passes:
 - 5:1 reducible
 - Sequential small writes randomized in size around average expected I/O size
 - 5% of data volume
- Aging is 5 passes:
 - 5:1 reducible
 - Random small writes randomized in size around average expected I/O size
 - 1% of data volume

Data Conditioning Script

```
compratio=5
```

```
*SD:
```

```
sd=default, openflags=o_direct
```

```
sd=sd1,lun=\\.\PhysicalDrive1
```

```
sd=sd2,lun=\\.\PhysicalDrive2
```

```
sd=sd3,lun=\\.\PhysicalDrive3
```

```
...
```

```
sd=sd37,lun=\\.\PhysicalDrive37
```

```
sd=sd38,lun=\\.\PhysicalDrive38
```

```
sd=sd39,lun=\\.\PhysicalDrive39
```

```
*WD:      Workload Definitions
```

```
wd=wd1,sd=sd*,seekpct=sequential
```

```
*RD:      Run Definitions
```

```
*Will run 1 test IO size with random (4k, 8k, 16k) for approximately 900 GiB
```

```
rd=rd1,wd=wd1,iorate=max,elapsed=1901,interval=5,rdpct=0,xfersize=(4k,128k,4k),threads=(16)
```

Run this 2 runs, the sequential IO specification localizes the data placement across 5% of the system, the 1901 elapsed is based on the IOPS for 16K size divided into the 2.6 GiB (5%).

Data Aging Script

compratio=5

*SD:

sd=default, openflags=o_direct

sd=sd1,lun=\\.\PhysicalDrive1

sd=sd2,lun=\\.\PhysicalDrive2

sd=sd3,lun=\\.\PhysicalDrive3

...

sd=sd37,lun=\\.\PhysicalDrive37

sd=sd38,lun=\\.\PhysicalDrive38

sd=sd39,lun=\\.\PhysicalDrive39

*WD: Workload Definitions

wd=wd1,sd=sd*,seekpct=random

*RD: Run Definitions

*Will run 1 test IO size with random (4k, 8k, 16k) for approximately 520 GiB

rd=rd1,wd=wd1,iorate=max, elapsed=380, interval=1, rdpct=0, xfersize=(4k,128k,4k),

threads=(16)

Run this 5 runs, the sequential IO specification localizes the data placement across 5% of the system, the 380 elapsed is based on the IOPS for 16K size divided into the 520TiB (1%).

Phase 2: Baseline Workload Tests

- Once the AFA is brought to a state that is considered a start point, actual testing can start
- The next test is the baseline workload
 - 20/80 read/write ratio, all sequential, mixed block sizes matching your actual distribution, data that exhibits a 5:1 data reduction ratio, and displays some I/O banding with drift
 - 65/35 read/write ratio, all random, mixed block sizes matching your actual distribution, data that exhibits a 5:1 data reduction ratio, and displays some I/O banding with drift
 - 35/65 read/write ratio, all random, mixed block sizes matching your actual distribution, data that exhibits a 5:1 data reduction ratio, and displays some I/O banding with drift
 - 80/20 read/write ratio, all sequential, mixed block sizes matching your actual distribution, data that exhibits a 5:1 data reduction ratio, and displays some I/O banding with drift
- Unfortunately (well, actually fortunately) the 840 doesn't exhibit banding or drift
- The V840 may exhibit banding but will not show drift

20/80 and 80/20 Read Percent Sequential Workloads

*SD: Storage Definitions
sd=default, openflags=o_direct
sd=sd1,lun=\\.\PhysicalDrive1
sd=sd2,lun=\\.\PhysicalDrive2
sd=sd3,lun=\\.\PhysicalDrive3

...

sd=sd37,lun=\\.\PhysicalDrive37
sd=sd38,lun=\\.\PhysicalDrive38
sd=sd39,lun=\\.\PhysicalDrive39

*WD: Workload Definitions
wd=wd1,sd=sd*,seekpct=sequential

*RD: Run Definitions

*Will run 40 tests (10 for 512 byte, 10 for 8k, 10 for 16k, 10 for 128k) for 120 seconds each
rd=rd1,wd=wd1,iorate=max,elapsed=300,interval=1,pause=5,forrdpct=(20,80),forxfersize=(8k,16k,32k,128k),forthreads=(1,16,d)

35/65 and 65/35 Read Percent Random Workloads

*SD: Storage Definitions
sd=default, openflags=o_direct
sd=sd1,lun=\\.\PhysicalDrive1
sd=sd2,lun=\\.\PhysicalDrive2
sd=sd3,lun=\\.\PhysicalDrive3

...

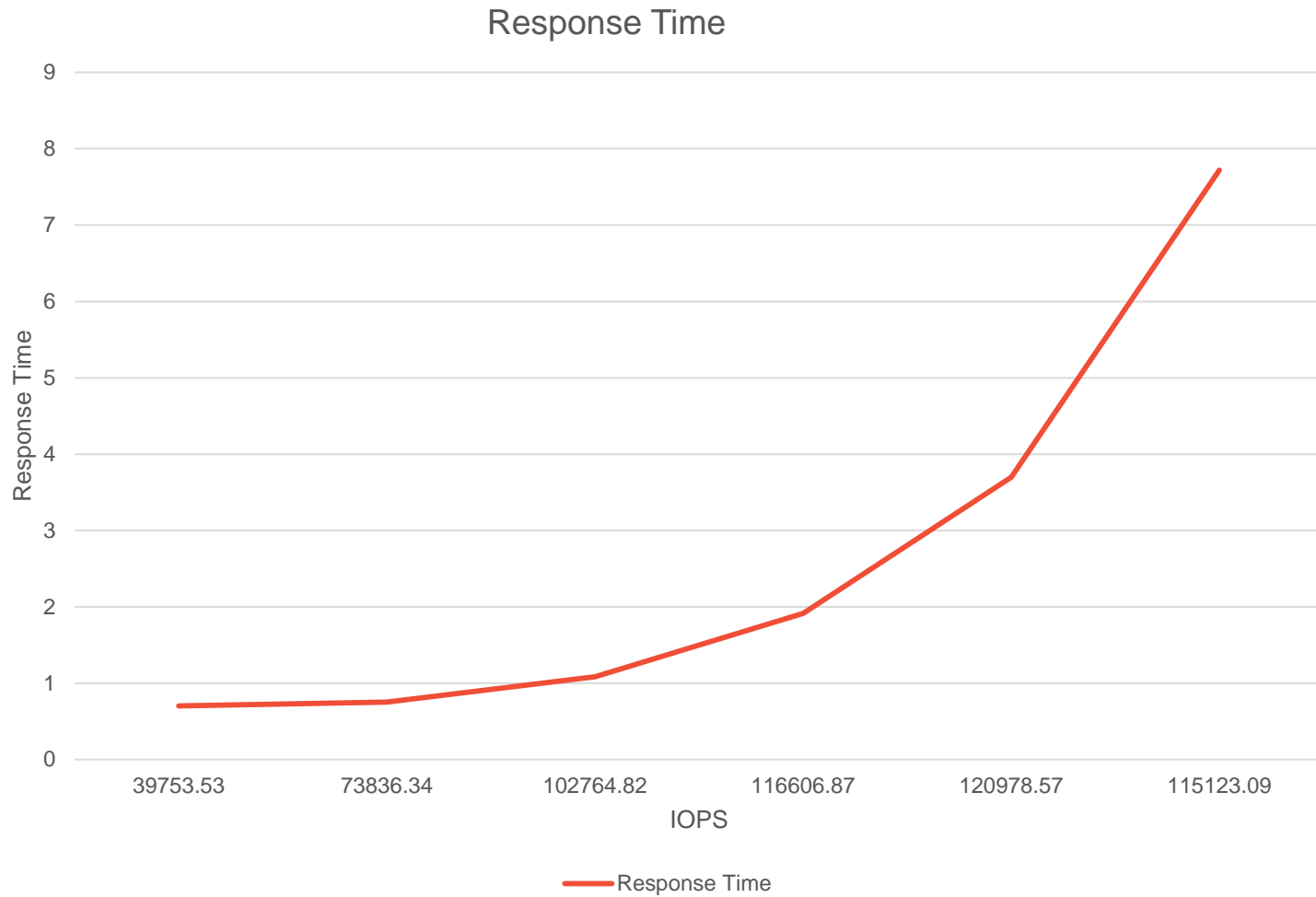
sd=sd37,lun=\\.\PhysicalDrive37
sd=sd38,lun=\\.\PhysicalDrive38
sd=sd39,lun=\\.\PhysicalDrive39

*WD: Workload Definitions
wd=wd1,sd=sd*,seekpct=random

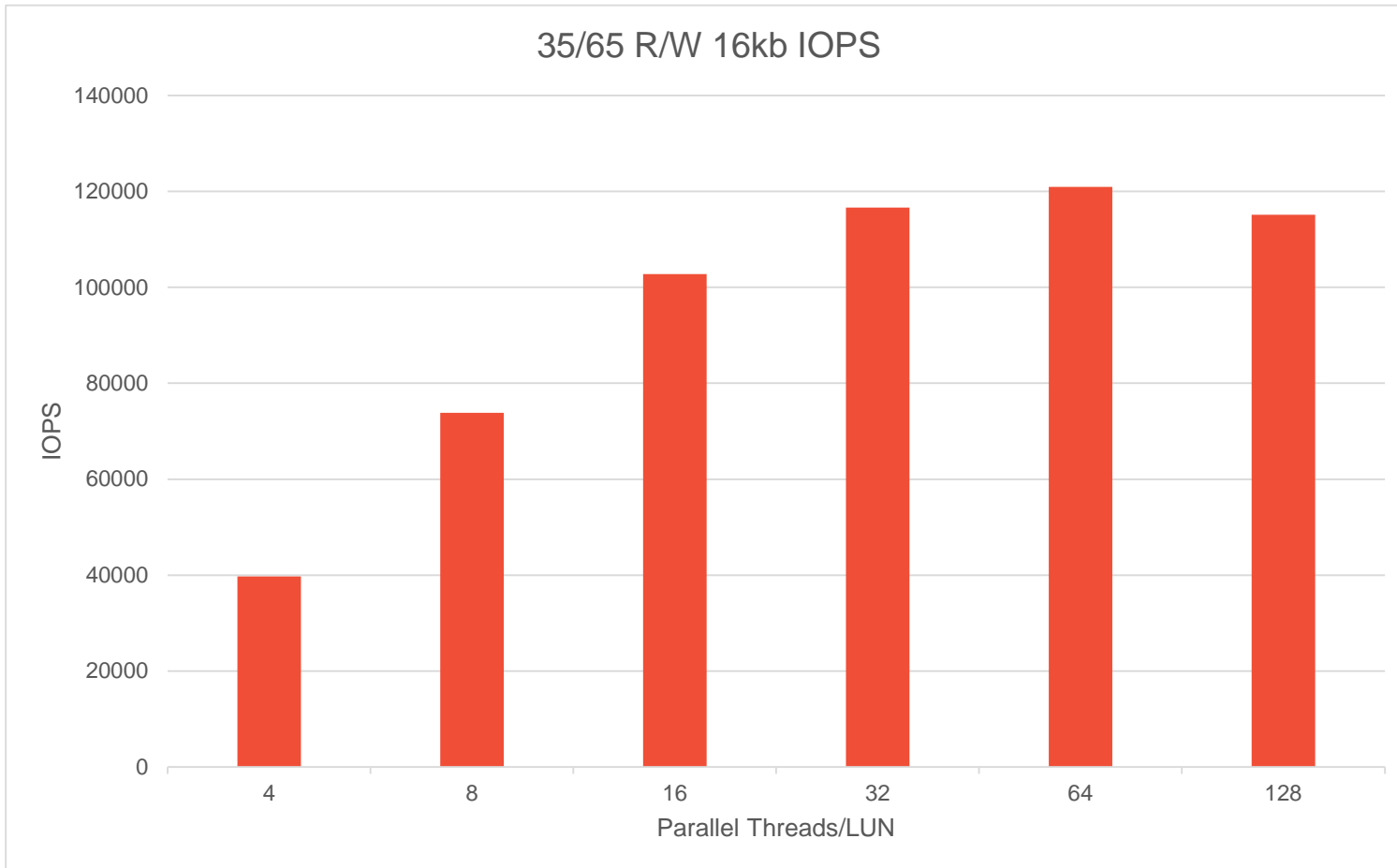
*RD: Run Definitions

*Will run 40 tests (10 for 512 byte, 10 for 8k, 10 for 16k, 10 for 128k) for 120 seconds each
rd=rd1,wd=wd1,iorate=max,elapsed=300,interval=1,pause=5,forrdpct=(35,65),forxfersize=(8k,
16k, 32k,128k),forthreads=(1,16,d)

Determine the Inflection Point



A Better Method May be IOPS



Phase 3: Functional Testing

- Applies to full SAN type models
 - IBM FlashSystem V840
 - Violin
- Will be dependent on functions available
 - Thin provisioning
 - Snapshots
 - Replication
 - Encryption – All 840s do this transparently
 - Copy
 - Backup
 - Etc.
- Not covered in this presentation since it is array specific

Phase 4: Fault Injection Testing

- Determine failure scenarios to test
- Establish base line, steady state mixed workload
- Test Scenarios
- Example Scenarios
 - Fail a path
 - Fail a drive (or flash module)
 - If the array claims to support it, fail two drives (or flash modules) in the same RAID group simultaneously
 - Fail a controller
 - Fail a power supply (and fail a fan separately if the array supports that)
 - Perform a controller firmware upgrade
 - Expand capacity by adding a shelf online

4KB 20/80 load

4kb_20_80_seq.cfg

*SD: Storage Definitions

sd=default, openflags=o_direct

sd=sd1,lun=\\.\PhysicalDrive1

sd=sd2,lun=\\.\PhysicalDrive2

sd=sd3,lun=\\.\PhysicalDrive3

sd=sd4,lun=\\.\PhysicalDrive4

sd=sd5,lun=\\.\PhysicalDrive5

sd=sd6,lun=\\.\PhysicalDrive6

sd=sd7,lun=\\.\PhysicalDrive7

sd=sd8,lun=\\.\PhysicalDrive8

sd=sd9,lun=\\.\PhysicalDrive9

sd=sd10,lun=\\.\PhysicalDrive10

*WD: Workload Definitions

wd=wd1,sd=sd*,seekpct=sequential

*RD: Run Definitions

*Will run 1 test 4kb sequential 2 hours long

rd=rd1,wd=wd1,iorate=max,elapsed=7200,interval=1,forrdpct=(20),forxfersize=(4k),forthreads=(32)

8KB 65/35 Load

8kb_65_35_ran.cfg

*SD: Storage Definitions

sd=default, openflags=o_direct

sd=sd11,lun=\\.\PhysicalDrive11

sd=sd12,lun=\\.\PhysicalDrive12

sd=sd13,lun=\\.\PhysicalDrive13

sd=sd14,lun=\\.\PhysicalDrive14

sd=sd15,lun=\\.\PhysicalDrive15

sd=sd16,lun=\\.\PhysicalDrive16

sd=sd17,lun=\\.\PhysicalDrive17

sd=sd18,lun=\\.\PhysicalDrive18

sd=sd19,lun=\\.\PhysicalDrive19

sd=sd20,lun=\\.\PhysicalDrive20

*WD: Workload Definitions

wd=wd1,sd=sd*,seekpct=sequential

*RD: Run Definitions

*Will run 1 test 8kb random 2 hours long

rd=rd1,wd=wd1,iorate=max,elapsed=7200,interval=1,forrdpct=(65),forxfersize=(8k),forthreads=(16)

64 KB 65/35 Load

64kb_65_35_ran.cfg

*SD: Storage Definitions

sd=default, openflags=o_direct

sd=sd21,lun=\\.\PhysicalDrive21

sd=sd22,lun=\\.\PhysicalDrive22

sd=sd23,lun=\\.\PhysicalDrive23

sd=sd24,lun=\\.\PhysicalDrive24

sd=sd25,lun=\\.\PhysicalDrive25

sd=sd26,lun=\\.\PhysicalDrive26

sd=sd27,lun=\\.\PhysicalDrive27

sd=sd28,lun=\\.\PhysicalDrive28

sd=sd29,lun=\\.\PhysicalDrive29

sd=sd30,lun=\\.\PhysicalDrive30

*WD: Workload Definitions

wd=wd1,sd=sd*,seekpct=random

*RD: Run Definitions

*Will run 1 test 64kb 2 hours long

rd=rd1,wd=wd1,iorate=max,elapsed=7200,interval=1,forrdpct=(65),forxfersize=(64k),forthread
s=(8)

128 KB 80/20 Load

128kb_80_20_seq.cfg

*SD: Storage Definitions

sd=default, openflags=o_direct

sd=sd31,lun=\\.\PhysicalDrive31

sd=sd32,lun=\\.\PhysicalDrive32

sd=sd33,lun=\\.\PhysicalDrive33

sd=sd34,lun=\\.\PhysicalDrive34

sd=sd35,lun=\\.\PhysicalDrive35

sd=sd36,lun=\\.\PhysicalDrive36

sd=sd37,lun=\\.\PhysicalDrive37

sd=sd38,lun=\\.\PhysicalDrive38

sd=sd39,lun=\\.\PhysicalDrive39

*WD: Workload Definitions

wd=wd1,sd=sd*,seekpct=sequential

*RD: Run Definitions

*Will run 1 test 128kb 2 hours long

rd=rd1,wd=wd1,iorate=max,elapsed=7200,interval=1,forrdpct=(80),forxfersize=(128k),forthreads=(4)

Run Loads

Capture outputs to C:\vdbench\output as follows:

Use 4 different sessions and run one of the following commands in each:

```
c:\vdbench\vdbench -f 4kb_20_80_seq.cfg -o  
c:\vdbench\output\day_three_4kb -m 10
```

```
c:\vdbench\vdbench -f 8kb_65_35_ran.cfg -o  
c:\vdbench\output\day_three_8kb -m 10
```

```
c:\vdbench\vdbench -f 64kb_65_35_ran.cfg -o  
c:\vdbench\output\day_three_64kb -m 10
```

```
c:\vdbench\vdbench -f 128kb_80_20_seq.cfg -o  
c:\vdbench\output\day_three_128kb -m 9
```

Do Failures

For the 840 we did the following:

- Fail a path
- Reboot a controller
- Fail a controller (unrack controller)
- Fail a module
- We found the test only required 1.5 hour so we did these additional tests:
 - Fail a PSU (pull out cord)
 - Fail a battery (pull out battery module)

Phase 5: Soak Test

- Use the 4 loads from phase 2
- Run each for 12 hours (48 consecutive hours)
- Review results for performance anomalies

Summary

- Testing and comparing systems can be difficult
- Utilizing IDC guidelines testing is made more consistent
- Using tools like VDBench provides a repeatable and consistent test framework

Using Oracle VDBench to Implement IDC
All Flash Array Testing

Questions?

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