IOPS Performance Testing with SupremeRAID™

SupremeRAID™ v1.5 Improves Performance Up To 7x At Low IO Depths

Executive Summary

SupremeRAID™ by Graid Technology uses GPU-based acceleration to deliver extremely high RAID performance. Using SupremeRAID™ avoids the inherent performance limitations in other RAID products, including ASIC-based hardware RAID and CPU-based software RAID.

Updating to the latest SupremeRAID™ version 1.5 software further increases IO throughput. The benefits are significant for all RAID levels, with SupremeRAID™ RAID 6 and RAID 5 random read IOPS at low queue depths increasing up to 5X. With SupremeRAID™ RAID 10, random read IOPS at low queue depths increase up to 6X, and random write IOPS increase up to 7X. Importantly, these performance gains occur without compromising performance elsewhere.

The following graph visualizes three examples of these performance gains. The broken lines represent the previous SupremeRAID™ software version 1.3, and the solid lines represent the latest SupremeRAID™ software version 1.5. Note that performance significantly improves for all test cases shown. Similar gains occur for RAID 5 and RAID 10, as shown in the following pages.

RAID 6 Random Read IOPS Performance (16PD)
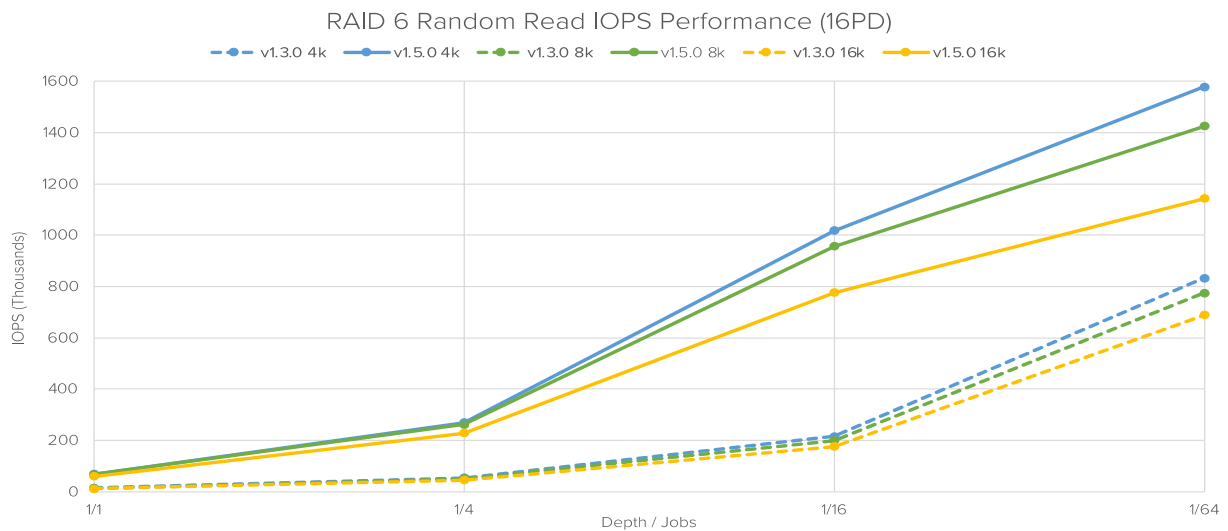
Introduction

About this Test

Testing Background

Hardware

- Server: Dell PowerEdge R750
- Processor: Intel® Xeon® Gold 6338 CPU @ 2.00GHz x 2
- Memory: Hynix M393A4G43BB4-CWE 32GB DDR4 3200Mhz x 16
- RAID Controller: SupremeRAID™ SR-1010 SR-BUN-1010-12-FD32 x 1
- SSD: Solidigm D7-P5520 x 16

Software

- Operating System: Red Hat Enterprise 8.8
- Kernel: 4.18.0-477.10.1.el8_8.x86_64
- NVIDIA: NVIDIA-Linux-x86_64-515.86.01.run
- SupremeRAID™ Driver Version
    - 1.3: 1.3.0-186-128-x86_64
    - 1.5: 1.5.0-rc1-010-644-65-x86_64
- Benchmark Tool: Fio-3.30

Configuration

Drive Groups

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RAID5
|———————————|———————|————————|—————————————|———————|—————————————|———————————————————————————|——————————————|
| DG ID     | MODE  | VD NUM | CAPACITY    | FREE  | USED        | CONTROLLER                | STATE        |
|———————————|———————|————————|—————————————|———————|—————————————|———————————————————————————|——————————————|
| 0         | RAID5 | 1      | 40.3 TiB    | 0 B   | 40.3 TiB    | running: 0 prefer: 0      | OPTIMAL      |
|———————————|———————|————————|—————————————|———————|—————————————|———————————————————————————|——————————————|

RAID6
|———————————|———————|————————|—————————————|———————|—————————————|———————————————————————————|——————————————|
| DG ID     | MODE  | VD NUM | CAPACITY    | FREE  | USED        | CONTROLLER                | STATE        |
|———————————|———————|————————|—————————————|———————|—————————————|———————————————————————————|——————————————|
| 0         | RAID6 | 1      | 37.6 TiB    | 0 B   | 37.6 TiB    | running: 0 prefer: 0      | OPTIMAL      |
|———————————|———————|————————|—————————————|———————|—————————————|———————————————————————————|——————————————|

RAID10
|———————————|————————|————————|—————————————|———————|—————————————|———————————————————————————|——————————————|
| DG ID     | MODE   | VD NUM | CAPACITY    | FREE  | USED        | CONTROLLER                | STATE        |
|———————————|————————|————————|—————————————|———————|—————————————|———————————————————————————|——————————————|
| 0         | RAID10 | 1      | 21.5 TiB    | 0 B   | 21.5 TiB    | running: 0 prefer: 0      | OPTIMAL      |
|———————————|————————|————————|—————————————|———————|—————————————|———————————————————————————|——————————————|
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Virtual Drives

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RAID5
|——————————|————————|————————|——————————————|——————————|——————————|
| VD ID     | DG ID  | SIZE    | DEVICE PATH  | STATE    | EXPORTED |
|——————————|————————|————————|——————————————|——————————|——————————|
| 0         | 0      | 40.3 TiB| /dev/gdg0n1  | OPTIMAL  | No       |
|——————————|————————|————————|——————————————|——————————|——————————|

RAID6
|——————————|————————|————————|——————————————|——————————|——————————|
| VD ID     | DG ID  | SIZE    | DEVICE PATH  | STATE    | EXPORTED |
|——————————|————————|————————|——————————————|——————————|——————————|
| 0         | 0      | 37.6 TiB| /dev/gdg0n1  | OPTIMAL  | No       |
|——————————|————————|————————|——————————————|——————————|——————————|

RAID10
|——————————|————————|————————|——————————————|——————————|——————————|
| VD ID     | DG ID  | SIZE    | DEVICE PATH  | STATE    | EXPORTED |
|——————————|————————|————————|——————————————|——————————|——————————|
| 0         | 0      | 21.5 TiB| /dev/gdg0n1  | OPTIMAL  | No       |
|——————————|————————|————————|——————————————|——————————|——————————|
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Benchmark

FIO

The FIO (Flexible I/O) synthetic benchmark tests for storage performance using various operations, including random reads, random writes, sequential reads, and sequential writes across a mix of multiple thread counts and queue depths.

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Testing Results

Comparison performance testing occurred using the most recent SupremeRAID™ software, versions 1.5.0 and 1.3.0. This testing measured the performance gains after updating to v1.5.0 software. Comparison tables and graphs for RAID 6, 5, and 10 appear on the following pages.
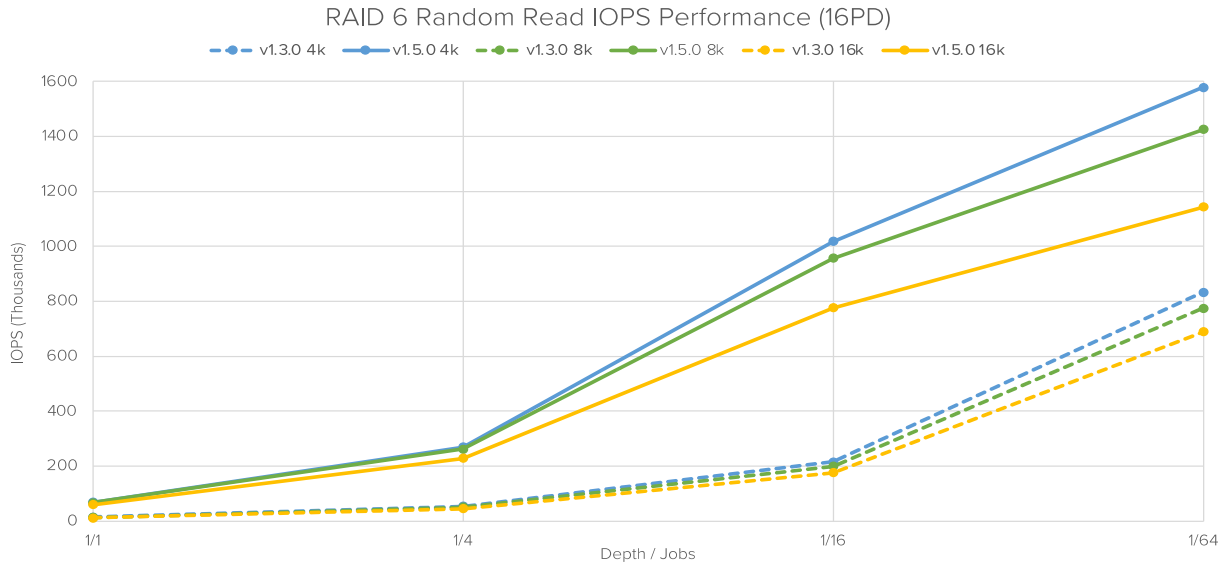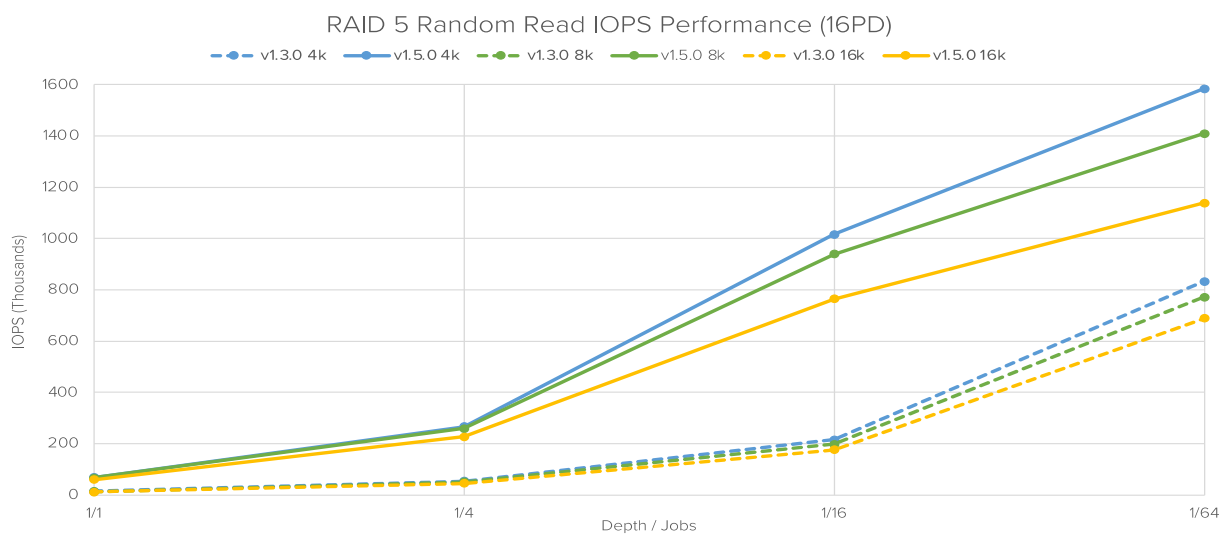
RAID 6 Performance

The updated SupremeRAID™ software delivers better IOPS performance for RAID 6 – with improvements ranging from 530% to 166% – during random reads. The updated software has slightly better or similar IOPS performance during random reads at queue depths of 4, 16, and 64, so this data is not shown.

RAID 6 Random Read IOPS Performance

Driver	Block Size	1 Job	4 Jobs	16 Jobs	64 Jobs
v1.3.0	4KB	13,597	53,696	214,804	832,472
v1.5.0	4KB	68,272	268,429	1,018,281	1,578,070
	Improvement	502%	500%	474%	190%
v1.3.0	8KB	12,748	50,171	198,407	775,205
v1.5.0	8KB	67,193	261,432	956,179	1,425,288
	Improvement	527%	521%	482%	184%
v1.3.0	16KB	11,290	44,409	176,000	688,906
v1.5.0	16KB	59,783	228,633	776,122	1,142,693
	Improvement	530%	515%	441%	166%

Tested using SupremeRAID™ SR-1010 and 16 SSDs at a queue depth of one.

RAID 6 Random Read IOPS Performance (16PD)

Importantly, these random read performance gains occur without compromising performance elsewhere (e.g., random writes).

RAID 6 Random Write IOPS Performance

Driver	Block Size	1 Job	4 Jobs	16 Jobs	64 Jobs
v1.3.0	4KB	4,823	19,210	72,445	236,757
v1.5.0	4KB	4,828	19,061	72,158	237,204
	Change	0%	-1%	0%	0%
v1.3.0	8KB	4,300	17,055	63,977	208,011
v1.5.0	8KB	4,234	16,923	63,948	208,773
	Change	-2%	-1%	0%	0%
v1.3.0	16KB	3,088	12,349	46,058	151,009
v1.5.0	16KB	3,068	12,173	45,177	149,902
	Change	-1%	-1%	-2%	-1%

Tested using SupremeRAID™ SR-1010 and 16 SSDs at a queue depth of one.

RAID 5 Performance

The updated SupremeRAID™ software delivers better IOPS performance for RAID 5 – with improvements ranging from 530% to 166% – during random reads. The updated software has slightly better or similar IOPS performance during random reads at queue depths of 4, 16, and 64, so this data is not shown.

RAID 5 Random Read IOPS Performance

Driver	Block Size	1 Job	4 Jobs	16 Jobs	64 Jobs
v1.3.0	4KB	13,579	53,654	214,797	833,009
v1.5.0	4KB	67,540	265,454	1,016,541	1,583,835
	Improvement	497%	495%	473%	190%
v1.3.0	8KB	12,687	49,939	197,623	771,451
v1.5.0	8KB	66,083	258,121	939,757	1,408,896
	Improvement	521%	517%	476%	183%
v1.3.0	16KB	11,310	44,248	175,435	688,076
v1.5.0	16KB	59,169	226,572	764,692	1,138,991
	Improvement	523%	512%	436%	166%

Tested using SupremeRAID™ SR-1010 and 16 SSDs at a queue depth of one.

RAID 5 Random Read IOPS Performance (16PD)

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Importantly, these random read performance gains occur without compromising performance elsewhere (e.g., random writes).

RAID 5 Random Write IOPS Performance

Driver	Block Size	1 Job	4 Jobs	16 Jobs	64 Jobs
v1.3.0	4KB	5,461	21,704	82,234	270,280
v1.5.0	4KB	53,53	21,374	81,965	273,522
	Change	-2%	-2%	0%	1%
v1.3.0	8KB	4,809	19,045	71,146	231,165
v1.5.0	8KB	4,750	18,853	71,024	231,147
	Change	-1%	-1%	0%	0%
v1.3.0	16KB	3,364	13,489	50,478	166,496
v1.5.0	16KB	3,435	13,706	51,649	174,017
	Change	+2%	+2%	+2%	+5%

Tested using SupremeRAID™ SR-1010 and 16 SSDs at a queue depth of one.

RAID 10 Performance

The updated SupremeRAID™ software delivers better IOPS performance for RAID 10 – with improvements ranging from 674% to 192% – during random reads. Also, the updated software has better IOPS performance for RAID 10 – with gains ranging from 725% to 160% – during random write with a queue depth of 1. The updated software delivers slightly better to identical IOPS performance at queue depths of 4, 16, and 64, so this data is not shown.

RAID 10 Random Read IOPS Performance

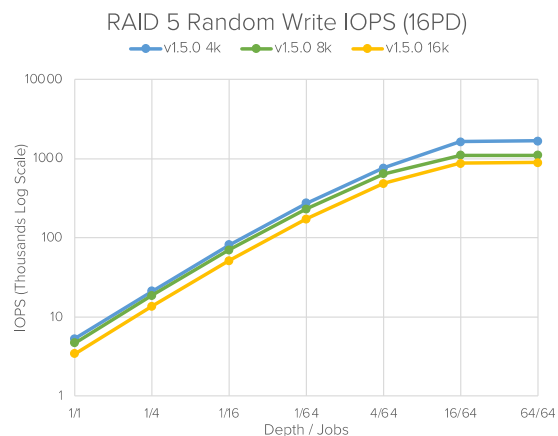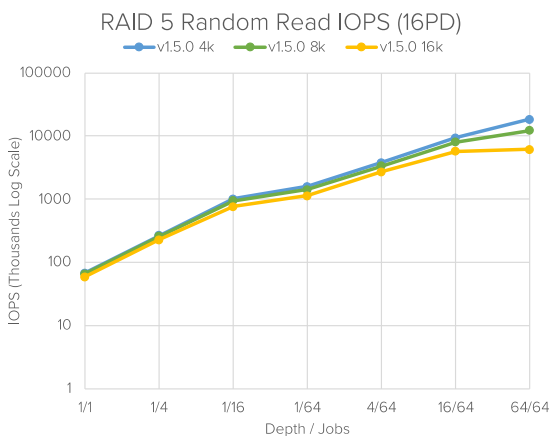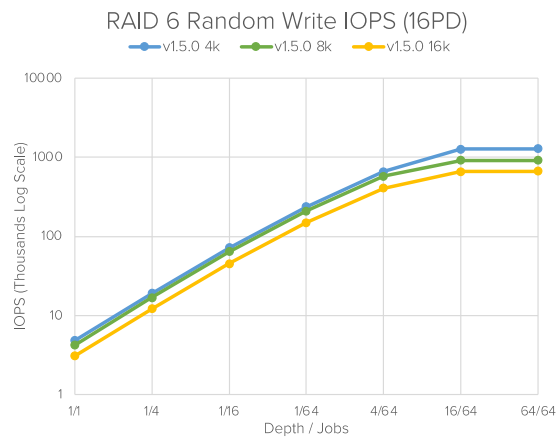| Driver	Block Size	1 Job	4 Jobs	16 Jobs	64 Jobs
v1.3.0	4KB	12,892	50,965	203,636	796,770
v1.5.0	4KB	69,219	270,976	1,043,715	1,568,646
	Improvement	537%	532%	513%	197%
v1.3.0	8KB	10,905	43,173	172,906	681,131
v1.5.0	8KB	67,211	260,713	961,110	1,373,826
	Improvement	616%	604%	556%	202%
v1.3.0	16KB	8,919	35,378	141,381	563,436
v1.5.0	16KB	60,093	228,701	789,926	1,081,545
	Improvement	674%	646%	559%	192%

Tested using SupremeRAID™ SR-1010 and 16 SSDs at a queue depth of one.
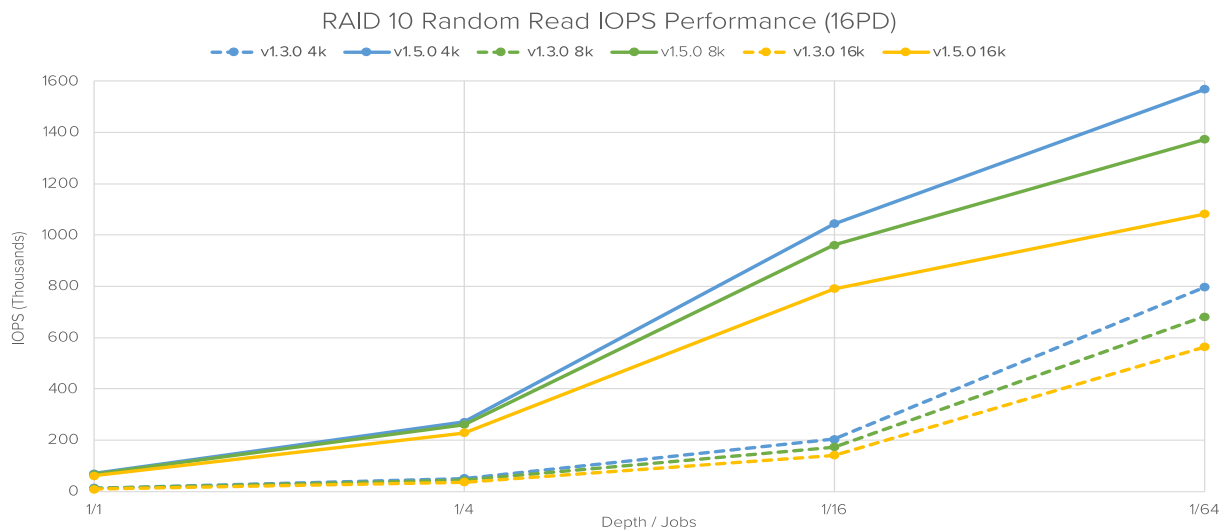
RAID 10 Random Read IOPS Performance (16PD)

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RAID 10 Random Write IOPS Performance

Driver	Block Size	1 Job	4 Jobs	16 Jobs	64 Jobs
v1.3.0	4KB	10,628	41,812	167,798	664,029
v1.5.0	4KB	59,710	231,237	849,036	1,232,994
	Improvement	562%	553%	506%	186%
v1.3.0	8KB	8,666	34,149	136,991	548,897
v1.5.0	8KB	57,611	211,359	678,428	957,409
	Improvement	665%	619%	495%	174%
v1.3.0	16KB	6,693	26,245	105,258	425,748
v1.5.0	16KB	48,525	167,782	475,436	682,985
	Improvement	725%	639%	452%	160%

Tested using SupremeRAID™ SR-1010 and 16 SSDs at a queue depth of one.

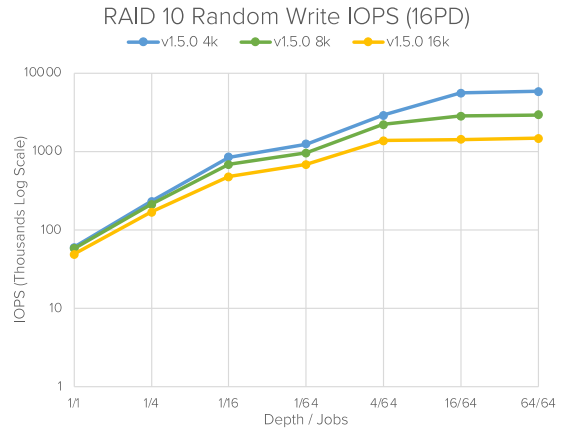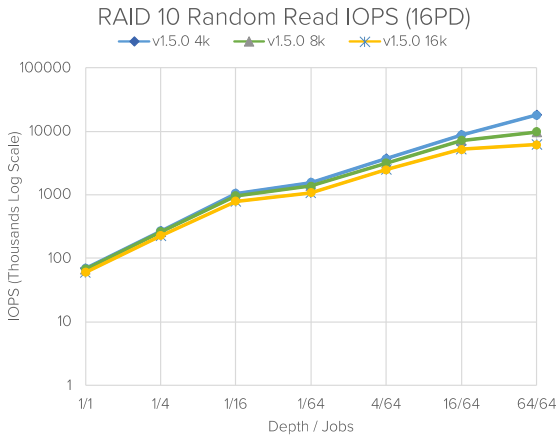RAID 10 Random Write IOPS Performance (16PD)
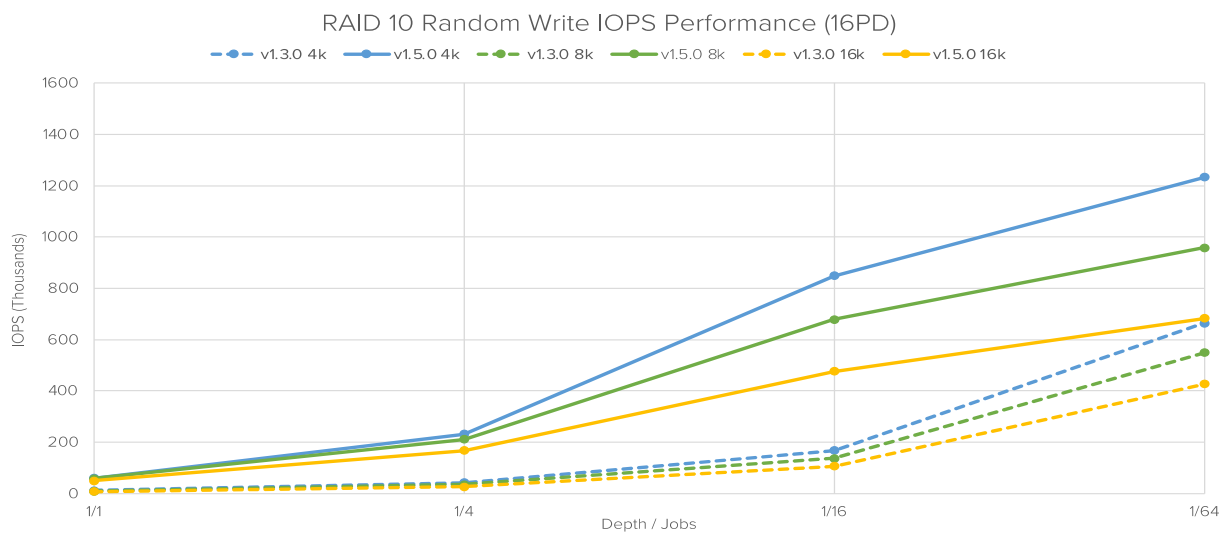
IOPS Performance Profiles

The following graphs show overall performance profiles when using the updated SupremeRAID™ software. Performance increases when the number of jobs ranges from 1 to 64 at a queue depth of one. Also, performance improves when queue depth and the number of jobs grow, demonstrating SupremeRAID™ very efficiently utilizes available SSD performance.

Note that the vertical axis of these graphs uses a logarithmic scale, so there is an order of magnitude difference (a factor of 10 or 10X) between each vertical line. In other words, IOPS performance increases by more than 100X across the ranges shown on the graphs.

RAID 6 Random Read IOPS (16PD)

RAID 6 Random Write IOPS (16PD)

RAID 5 Random Read IOPS (16PD)

RAID 5 Random Write IOPS (16PD)

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RAID 10 Random Read IOPS (16PD)

— v1.5.0 4k — v1.5.0 8k — v1.5.0 16k

RAID 10 Random Write IOPS (16PD)

— v1.5.0 4k — v1.5.0 8k — v1.5.0 16k

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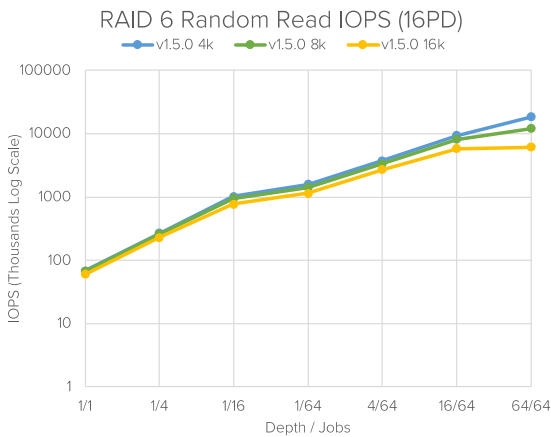
Conclusion

SupremeRAID™ by Graid Technology uses GPU-based acceleration to deliver extremely high RAID performance. Using SupremeRAID™ avoids the inherent performance limitations in other RAID products, including ASIC-based hardware RAID and CPU-based software RAID.

The efficient utilization of available SSD performance is improved by SupremeRAID™ software version 1.5, delivering significant performance gains. Benchmark testing demonstrates increases in IOPS by up to 7X and decreases in latency by up to 85% for random workloads at low queue depths. Many data center challenges involve overcoming IOPS and latency limitations, so using SupremeRAID™ offers a storage solution for accelerating diverse databases and applications.

Other benefits of the SupremeRAID™ software version 1.5 include the following:

- Up to 530% faster RAID 6 performance.
- Up to 523% faster RAID 5 performance.
- Up to 725% faster RAID 10 performance.

About Graid Technology

Graid Technology, creator of SupremeRAID™ next-generation GPU-based RAID, is led by a team of experts in the storage industry and is headquartered in Silicon Valley, California with an R&D center in Taipei, Taiwan. Designed for performance-demanding workloads, SupremeRAID™ is the fastest NVMe and NVMeoF RAID solution for PCIe Gen 3, 4, and 5 servers. A single SupremeRAID™ card delivers up to 28 million IOPS and up to 260 GB/s and supports up to 32 native NVMe drives, delivering superior NVMe/NVMeoF performance while increasing scalability, improving flexibility, and lowering TCO. For more information on Graid Technology, visit graidtech.com or connect with us on Twitter or LinkedIn.