



INTEL[®] VIRTUAL RAID ON CPU LINUX PERFORMANCE

NSG Host Storage Software

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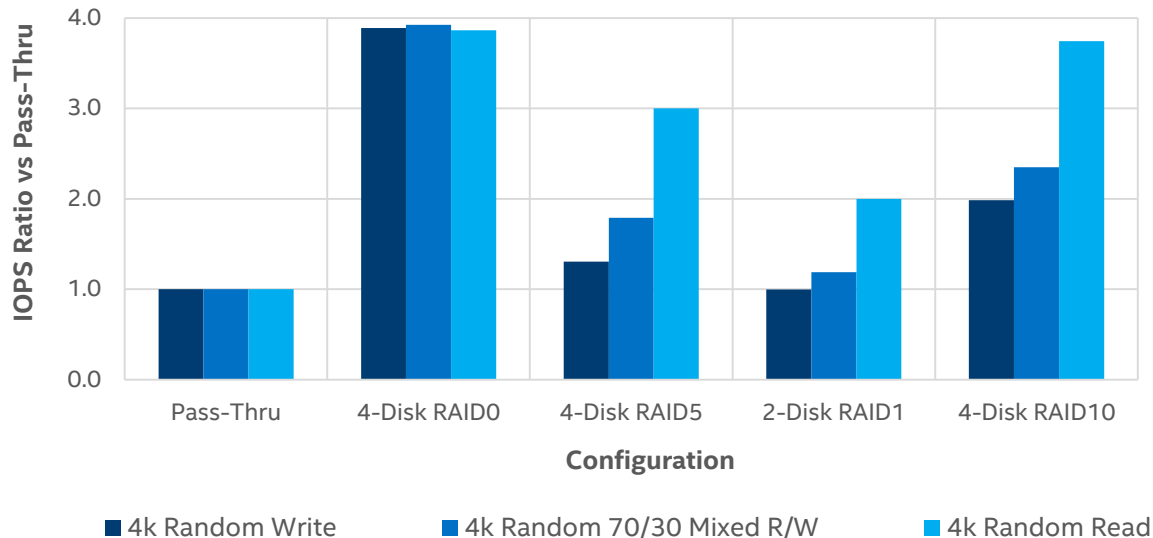
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Performance – RAID vs Pass-thru

RHEL7.4 with Intel® SSD DC P4510¹

(4k Random)



- Pass-thru raw data:
 - 4k Rand Write: 84k IOPS
 - 4k Rand Mixed: 183k IOPS
 - 4k Rand Read: 645k IOPS
- 4-Disk RAID0 Read: 2.5M IOPS
- Physical CPU Cores Used:
 - 4-Disk RAID0 Read: 4.7 Cores
 - 4-Disk RAID5 Write: 1.2 Cores

52 total physical cores on this 2 socket, Intel® Xeon® 8170 based system

See appendix for footnotes

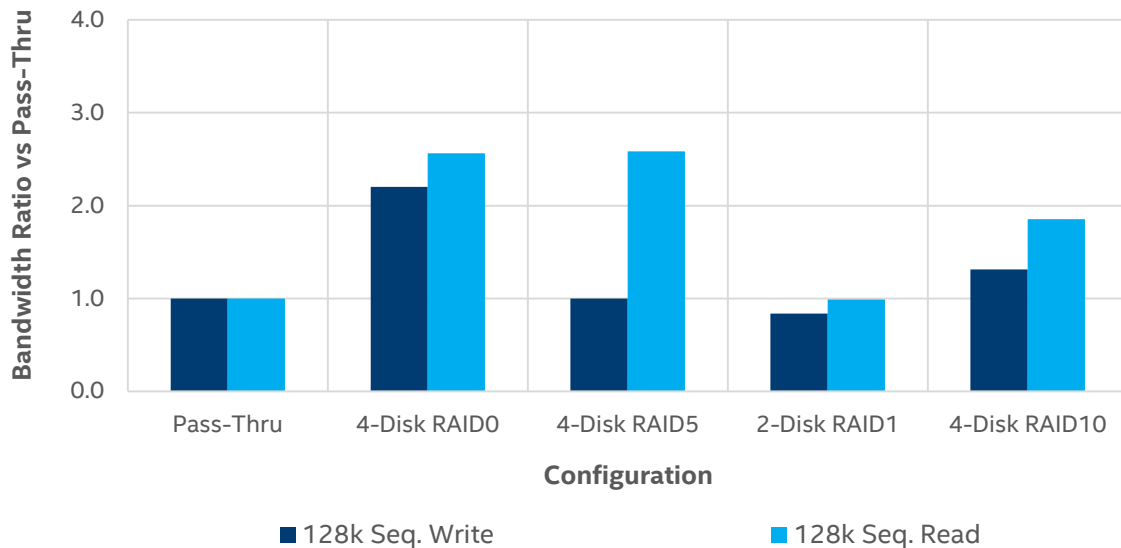
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Performance results are based on testing as of October 5, 2018 and may not reflect all publicly available security updates. See configuration disclosure for details. No product can be absolutely secure.

Performance – RAID vs Pass-thru

RHEL7.4 with Intel® SSD DC P4510²

(128k Seq., 1 Worker)



- Pass-thru raw data:
 - 128k Seq. Write: 1.7GB/s
 - 128k Seq. Read: 2.7 GB/s
- 4-Disk RAID 0 Read: 6.8 GB/s
- Physical CPU Cores Used:
 - 4-Disk RAID0 Read: 0.3 Cores
 - 4-Disk RAID5 Write: 1.0 Cores

52 total physical cores on this 2 socket, Intel® Xeon® 8170 based system

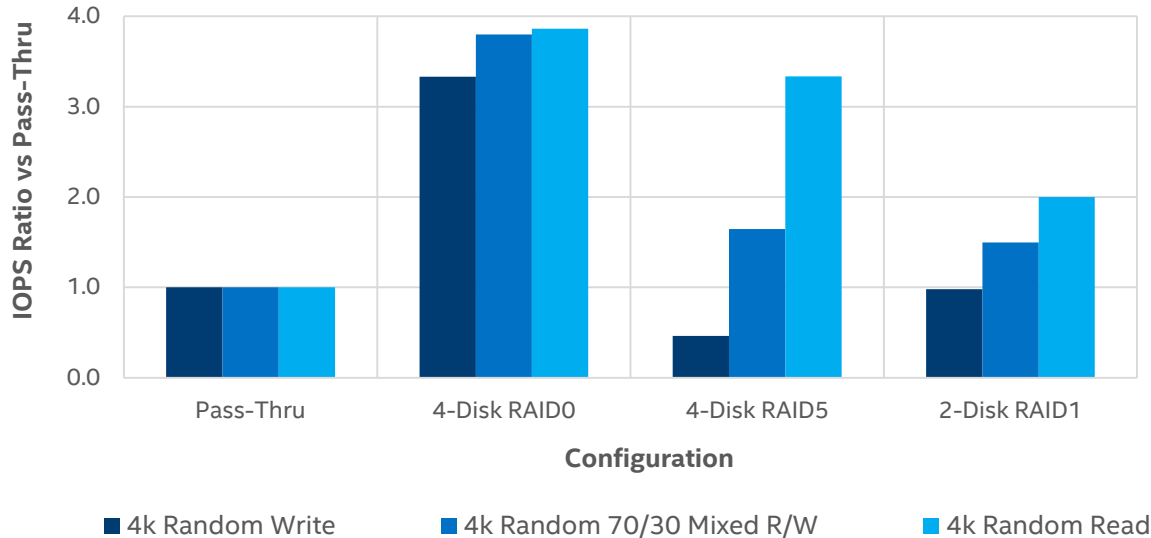
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Performance – RAID vs Pass-thru

RHEL7.4 with Intel® Optane™ SSD DC P4800X³ (4k Random)



- Pass-thru raw data:
 - 4k Rand Write: 558k IOPS
 - 4k Rand Mixed: 506k IOPS
 - 4k Rand Read: 586k IOPS
- 4-Disk RAID0 Read: 2.3M IOPS
- Physical CPU Cores Used:
 - 4-Disk RAID0 Read: 3.4 Cores
 - 4-Disk RAID5 Write: 3.3 Cores

52 total physical cores on this 2 socket, Intel® Xeon® 8170 based system

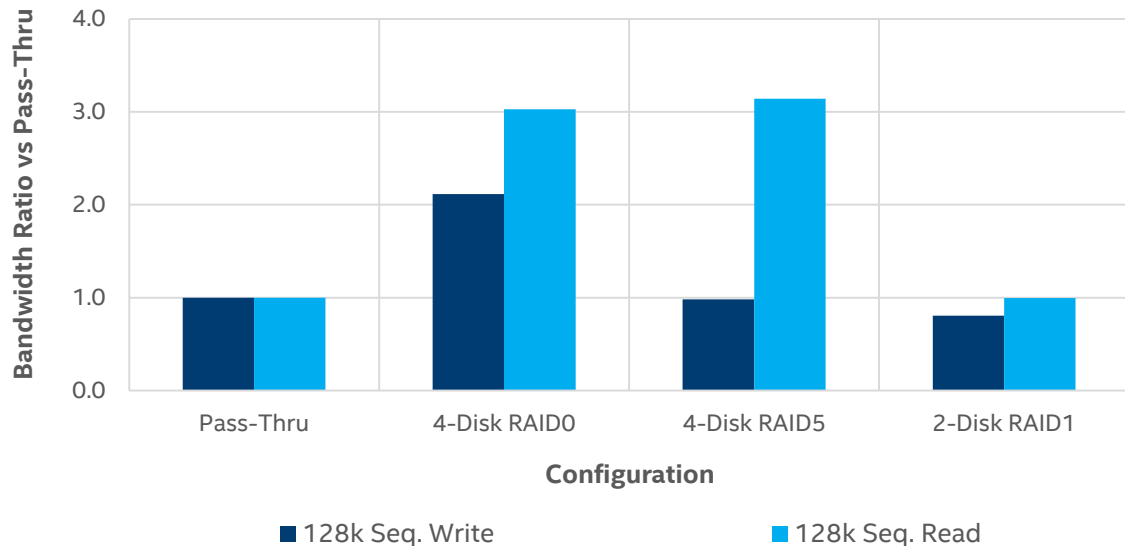
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Performance – RAID vs Pass-thru

RHEL7.4 with Intel® Optane™ SSD DC P4800X4 (128 Seq., 1 Worker)



See appendix for footnotes.

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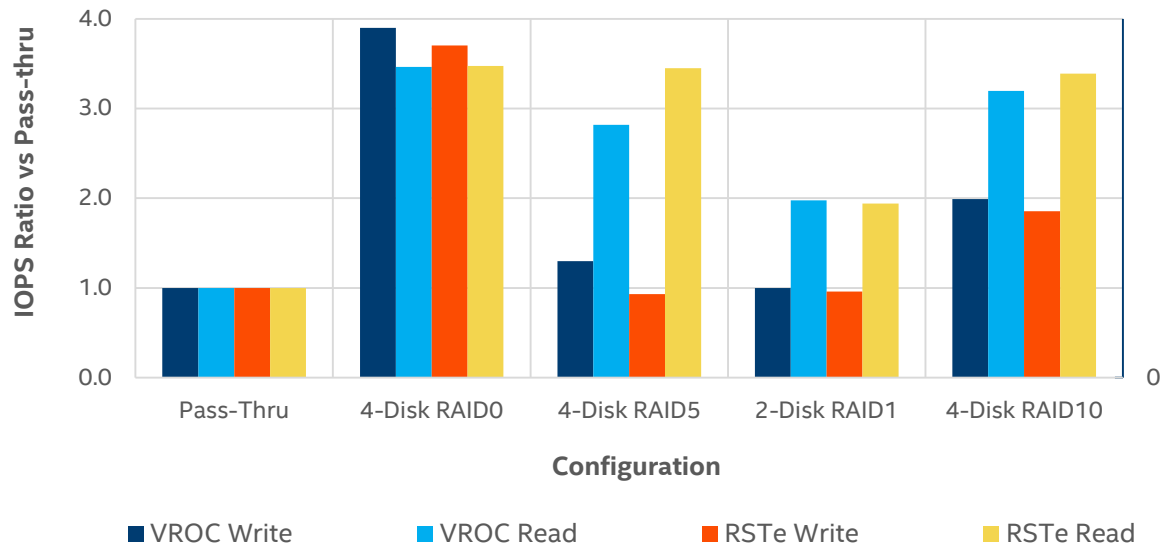
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- Pass-thru raw data:
 - 128k Seq. Write: 1.7GB/s
 - 128k Seq. Read: 2.7 GB/s
- 4-Disk RAID 0 Read: 8.1 GB/s
- Physical CPU Cores Used:
 - 4-Disk RAID0 Read: 0.5 Cores
 - 4-Disk RAID5 Write: 0.9 Cores

52 total physical cores on this 2 socket, Intel® Xeon® 8170 based system

Performance – NVMe* RAID vs SATA RAID

RHEL7.4 with Intel® SSD DC P4510/S4500⁵
(4k Random)



Pass-Thru Data

	Intel® VROC	Intel® RSTe SATA
4k Ran Write	84k IOPS	36k IOPS
4k Ran Read	62k IOPS	76k IOPS

4 Disk RAID 0 Read Comparison:

- Intel VROC (NVMe*): 2.1M IOPS
- Intel RSTe (SATA): 264k IOPS

52 total physical cores on this 2 socket, Intel® Xeon® 8170 based system

See appendix for footnotes.

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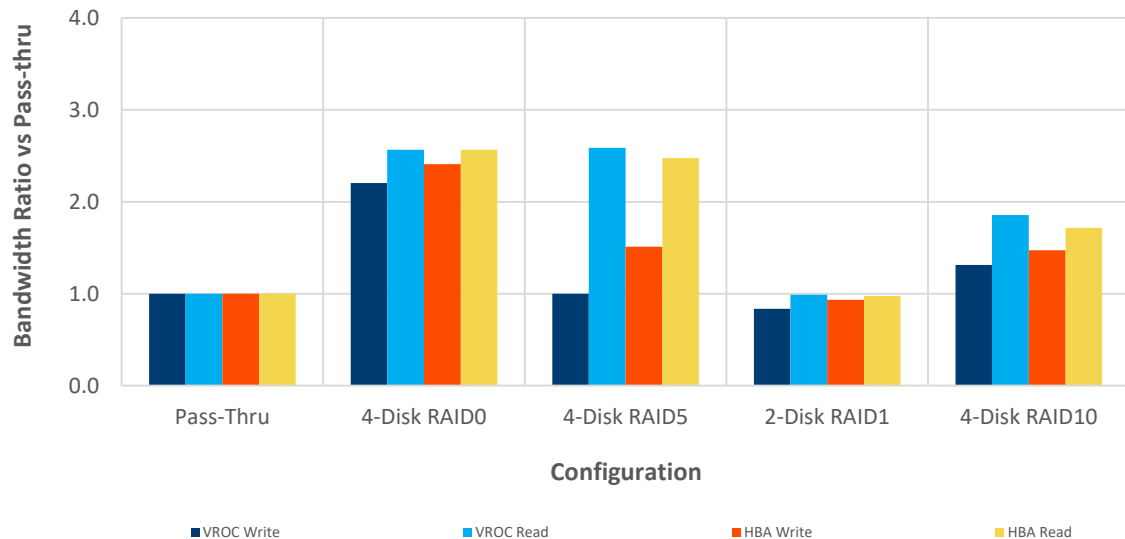
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Performance – RAID vs Pass-thru

RHEL7.4 with Intel® SSD DC P4510/S4500⁶

(128 Seq., 1 Worker)



Pass-Thru Data

	Intel® VROC	Intel® RSTe SATA
4k Ran Write	1.7 GB/s	0.4 GB/s
4k Ran Read	2.7 GB/s	0.5 GB/s

4 Disk RAID 0 Read Comparison:

- Intel VROC (NVMe^{*}): 6.8 GB/s
- Intel RSTe (SATA): 1.2 GB/s

52 total physical cores on this 2 socket, Intel® Xeon® 8170 based system

See appendix for footnotes.

Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more complete information visit www.intel.com/benchmarks.

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Appendix

1. **System configuration:** Intel® Server Board S2600WFT family, Intel® Xeon® 8170 Series Processors, 26cores@ 2.1GHz, RAM 192GB , BIOS Release 7/09/2018, BIOS Version: SE5C620.86B.00.01.0014.070920180847

OS: RedHat* Linux 7.4, kernel- 3.10.0-693.33.1.el7.x86_64, mdadm - v4.0 - 2018-01-26 Intel build: RSTe_5.4_WW4.5, Intel® VROC Pre-OS version 5.3.0.1039, 4x Intel® SSD DC P4510 Series 2TB drive firmware: VDV10131, Retimer

BIOS setting: Hyper-threading enabled, Package C-State set to C6(non retention state) and Processor C6 set to enabled, P-States set to default and SpeedStep and Turbo are enabled

Workload Generator: FIO 3.3, RANDOM: Workers-24, IOdepth- 256, No Filesystem, CPU Affinitized

Pass Thru Baseline: 1x Intel® SSD DC P4510 Series, 2 TB, Firmware: VDV10120, SSDPE2KX020T8

Performance results are based on testing as of October 5, 2018 and may not reflect all publicly available security updates. See configuration disclosure for details. No product can be absolutely secure.

2. **System configuration:** Intel® Server Board S2600WFT family, Intel® Xeon® 8170 Series Processors, 26cores@ 2.1GHz, RAM 192GB , BIOS Release 7/09/2018, BIOS Version: SE5C620.86B.00.01.0014.070920180847

OS: RedHat* Linux 7.4, kernel- 3.10.0-693.33.1.el7.x86_64, mdadm - v4.0 - 2018-01-26 Intel build: RSTe_5.4_WW4.5, Intel® VROC Pre-OS version 5.3.0.1039, 4x Intel® SSD DC P4510 Series 2TB drive firmware: VDV10131, Retimer

BIOS setting: Hyper-threading enabled, Package C-State set to C6(non retention state) and Processor C6 set to enabled, P-States set to default and SpeedStep and Turbo are enabled

Workload Generator: FIO 3.3, SEQUENTIAL: Workers-1, IOdepth- 128, No Filesystem, CPU Affinitized

Pass Thru Baseline: 1x Intel® SSD DC P4510 Series, 2 TB, Firmware: VDV10120, SSDPE2KX020T8

Performance results are based on testing as of October 5, 2018 and may not reflect all publicly available security updates. See configuration disclosure for details. No product can be absolutely secure.

3. **System configuration:** Intel® Server Board S2600WFT family, Intel® Xeon® 8170 Series Processors, 26cores@ 2.1GHz, RAM 192GB , BIOS Release 06/26/2018, BIOS Version: SE5C620.86B.00.01.0014.070920180847

OS: RedHat* Linux 7.4, kernel- 3.10.0-693.33.1.el7.x86_64, mdadm - v4.0 - 2018-01-26 Intel build: RSTe_5.4_WW4.5, Intel® VROC Pre-OS version 5.4.0.1039, 4x Intel® SSD DC P4800X Series 375GB drive firmware: E2010423, Retimer

BIOS setting: Hyper-threading enabled, Package C-State set to C6(non retention state) and Processor C6 set to enabled, P-States set to default and SpeedStep and Turbo are enabled

Workload Generator: FIO 3.6, RANDOM: Workers-8, IOdepth- 256, No Filesystem, CPU Affinitized

Pass-Thru Baseline: 1x Intel® SSD DC P4800X Series, 375 GB, Firmware: E2010423, SSDPE21K375GA)

Performance results are based on testing as of September 12, 2018 and may not reflect all publicly available security updates. See configuration disclosure for details. No product can be absolutely secure.

Appendix cont.

4. System configuration: Intel® Server Board S2600WFT family, Intel® Xeon® 8170 Series Processors, 26cores@ 2.1GHz, RAM 192GB , BIOS Release 06/26/2018, BIOS Version: SE5C620.86B.00.01.0014.070920180847

OS: RedHat* Linux 7.4, kernel- 3.10.0-693.33.1.el7.x86_64, mdadm - v4.0 - 2018-01-26 Intel build: RSTe_5.4_WW4.5, Intel® VROC Pre-OS version 5.4.0.1039, 4x Intel® SSD DC P4800X Series 375GB drive firmware: E2010423, Retimer

BIOS setting: Hyper-threading enabled, Package C-State set to C6(non retention state) and Processor C6 set to enabled, P-States set to default and SpeedStep and Turbo are enabled

Workload Generator: FIO 3.6, SEQUENTIAL: Workers-1, IOdepth- 128, No Filesystem, CPU Affinitized

Pass-Thru Baseline: 1x Intel® SSD DC P4800X Series, 375 GB, Firmware: E2010423, SSDPE21K375GA)

Performance results are based on testing as of September 12, 2018 and may not reflect all publicly available security updates. See configuration disclosure for details. No product can be absolutely secure.

5. System configuration: Intel® Server Board S2600WFT family, Intel® Xeon® 8170 Series Processors, 26cores@ 2.1GHz, RAM 192GB , BIOS Release 7/09/2018, BIOS Version: SE5C620.86B.00.01.0014.070920180847

OS: RedHat* Linux 7.4, kernel- 3.10.0-693.33.1.el7.x86_64, mdadm - v4.0 - 2018-01-26 Intel build: RSTe_5.4_WW4.5, Intel® VROC Pre-OS version 5.3.0.1039, 4x Intel® SSD DC P4510 Series 2TB drive firmware: VDV10131, 4x Intel® SSD DC S4500 Series 3.8TB drive firmware: SCV10121, Retimer

BIOS setting: Hyper-threading enabled, Package C-State set to C6(non retention state) and Processor C6 set to enabled, P-States set to default and SpeedStep and Turbo are enabled

Workload Generator: FIO 3.3, RANDOM: Workers-16, IOdepth- 256, No Filesystem, CPU Affinitized

Pass Thru Baseline: 1x Intel® SSD DC P4510 Series, 2 TB, Firmware: VDV10131, SSDPE2KX020T8; 1x Intel® SSD DC S4500 Series, 3.8TB, Firmware: SCV10120, SSDPE2KX020T8

Performance results are based on testing as of October 5, 2018 and may not reflect all publicly available security updates. See configuration disclosure for details. No product can be absolutely secure.

6. System configuration: Intel® Server Board S2600WFT family, Intel® Xeon® 8170 Series Processors, 26cores@ 2.1GHz, RAM 192GB , BIOS Release 7/09/2018, BIOS Version: SE5C620.86B.00.01.0014.070920180847

OS: RedHat* Linux 7.4, kernel- 3.10.0-693.33.1.el7.x86_64, mdadm - v4.0 - 2018-01-26 Intel build: RSTe_5.4_WW4.5, Intel® VROC Pre-OS version 5.3.0.1039, 4x Intel® SSD DC P4510 Series 2TB drive firmware: VDV10131, 4x Intel® SSD DC S4500 Series 3.8TB drive firmware: SCV10121, Retimer

BIOS setting: Hyper-threading enabled, Package C-State set to C6(non retention state) and Processor C6 set to enabled, P-States set to default and SpeedStep and Turbo are enabled

Workload Generator: FIO 3.3, SEQUENTIAL: Workers-1, IOdepth- 128, No Filesystem, CPU Affinitized

Pass Thru Baseline: 1x Intel® SSD DC P4510 Series, 2 TB, Firmware: VDV10131, SSDPE2KX020T8; 1x Intel® SSD DC S4500 Series, 3.8TB, Firmware: SCV10120, SSDPE2KX020T8

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