INTEL® VIRTUAL RAID ON CPU LINUX PERFORMANCE

NSG Host Storage Software
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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)

- 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

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Performance – NVMe* RAID vs SATA RAID
RHEL7.4 with Intel® SSD DC P4510/S4500
(4k Random)

Pass-Thru Data

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Intel® VROC</th>
<th>Intel® RSTe SATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>4k Ran Write</td>
<td>84k IOPS</td>
<td>36k IOPS</td>
</tr>
<tr>
<td>4k Ran Read</td>
<td>621k IOPS</td>
<td>76k IOPS</td>
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</table>

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

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Performance – RAID vs Pass-thru
RHEL7.4 with Intel® SSD DC P4510/S4500
(128 Seq., 1 Worker)

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

Pass-Thru Data

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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, Ioddepth- 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, Ioddepth- 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.

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, Ioddepth- 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
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.