NVM Express™ Delivering Real World Benefits

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NVMe value in client and data center

High performance  
Low latency

Expose the high bandwidth and low latency of PCIe SSDs with an optimized storage stack to reduce latency even further.

Industry Standard

Uses industry standard software and drivers for broad compatibility and management at scale. NVMe SMART for real time monitoring and health standardized across vendors.

Scalability

Improved parallelism with an efficient queuing mechanism enhances performance of multi-core CPUs and scalability.

Efficiency

Lean storage stack reduces CPU overhead for IO delivering more storage performance on the same server hardware, and reducing total cost of ownership.
Data center use cases for NVMe

Cloud computing
Better SLAs for CSPs, lower opx/capx, get developers to market faster, consumers services on demand

Virtualization
Lowering enterprise IT by increasing system utilization and improving virtual machine scalability

HPC
Eliminating bottlenecks in HPC workflows. NVMe keeps up with high bandwidth demands of HPC to speed up overall workflow times by an order of magnitude

Database
High performance and great QoS shine in traditional database

Big data
High bandwidth and low latency can provide business insights with real time analytics
Client use cases for NVMe

**Gaming**

Opens up the opportunity for unparalleled realism, with high quality textures and decreased load times.

**Content Creation**

NVMe creates opportunity for new workflows for content creation when working with large data sets.

**Workstation**

Opportunity to accelerate any WS workload with large data sets.
Caching from backend SAN in large organizations.

**Client / Mobile**

High performance is driving NVMe into client. Efficiency and features of NVNe lead to better battery life. Lower latency and better QoS delivers better application responsiveness.

**4K**

High bandwidth is required for real time 4K editing.
Breaking through the SATA bottleneck

Sequential Bandwidth

<table>
<thead>
<tr>
<th></th>
<th>Sequential Read</th>
<th>Sequential Write</th>
</tr>
</thead>
<tbody>
<tr>
<td>SATA 2.0</td>
<td>2500</td>
<td>500</td>
</tr>
<tr>
<td>SATA 3.0</td>
<td>2500</td>
<td>500</td>
</tr>
<tr>
<td>PCIe 2.0 (x2)</td>
<td>3000</td>
<td>600</td>
</tr>
<tr>
<td>PCIe 2.0 (x4)</td>
<td>3000</td>
<td>1200</td>
</tr>
<tr>
<td>PCIe 3.0 (x2)</td>
<td>3500</td>
<td>700</td>
</tr>
<tr>
<td>PCIe 3.0 (x4)</td>
<td>3500</td>
<td>1400</td>
</tr>
</tbody>
</table>

Effective Data Rate

- SATA 2.0: 500 MB/s
- SATA 3.0: 500 MB/s
- PCIe 2.0 (x2): 1000 MB/s
- PCIe 2.0 (x4): 2000 MB/s
- PCIe 3.0 (x2): 2500 MB/s
- PCIe 3.0 (x4): 5000 MB/s

Results measured by Intel based on the following configurations. Tests document performance of components on a particular test, in specific systems. Differences in hardware, software, or configuration will affect actual performance. Configurations: Performance claims obtained from data sheet, sequential read/write at 128k block size for NVMe and SATA. Intel SSD C P3700 Series 2TB, Intel SSD DC S3700 Series SATA 6Gbps. Intel Core i7-3770K CPU @ 3.50GHz, 8GB of system memory, Windows* Server 2012, IOMeter. Random performance is collected with 4 workers each with 32 QD.
Results measured by Intel based on the following configurations. Tests document performance of components on a particular test, in specific systems. Differences in hardware, software, or configuration will affect actual performance. Configurations:

- **ESXi 5.5, SATA SSD + HDD**: 350% higher IOPS, More VMs, Better QoS
- **ESXi 6.0, SATA SSD + NVMe**:
Lenovo ThinkServer RD650 with Intel® SSD DC P3700 Series Database TPC-H

7x PERFORMANCE

4 to 1 server consolidation

Total database performance

- Legacy Server - HDD
- ThinkServer RD 650 - SATA SSD
- ThinkServer RD 650 - NVMe

For tests and configurations go to http://www.principledtechnologies.com/Lenovo/RD650_storage_performance_0415.pdf

Tests document performance of components on a particular test, in specific systems. Differences in hardware, software, or configuration will affect actual performance.
Microsoft SQL for Big Data Analytics with NVMe™ Acceleration

<table>
<thead>
<tr>
<th>Performance /Hour</th>
<th>Time to Answer</th>
<th>Performance</th>
<th>Server Consolidation</th>
</tr>
</thead>
<tbody>
<tr>
<td>x7</td>
<td>1/2</td>
<td>x16.6</td>
<td>x4</td>
</tr>
</tbody>
</table>

- Queries/hr
- Reduce query time to 28 minutes, cutting the total time to answer in half
- Throughput of legacy solution
- Only need 1 server to do the work of 4 previous servers

For tests and configurations go to http://www.principledtechnologies.com/Lenovo/RD650_storage_performance_0415.pdf

Tests document performance of components on a particular test, in specific systems. Differences in hardware, software, or configuration will affect actual performance.
Time to Answer reduced by

92%

complete 12x jobs in
14% less time

Jobs per hour

x14

number of jobs
per hour

Server consolidation

x6

24U of servers can be
replaced with a single 4U
E7v3 server

Performance

x21.4

The throughput

0.7GB/s

2.2GB/s

15.0GB/s

Legacy Server

Intel® Xeon™
E5 v2 server
(SATA SSDs)

Intel® Xeon™
E7 v3 server
(PCIe® SSDs)

For tests and configurations go to http://www.principledtechnologies.com/SAS/SAS_Intel_E5_E7_0415.pdf
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AnandTech NVMe Benchmarks

Trace of Photo Sync/Editing, Gaming, Virtualization, Productivity, Video Playback, App development

Source: http://www.anandtech.com/show/9396/samsung-sm951-nvme-256gb-pcie-ssd-review/4
Dual 4K video editing in real time made possible with NVMe™

Real time 4k editing made possible

Design & build richer content with larger data sets, textures and assets

NVMe SSD = ~2.5x (frames/sec) SATA SSD
NVMe SSD = ~8x (frames/sec) SATA HHD
Architected for Performance