Achieving Transformative Application Performance with Vexata Systems and Intel® Xeon® Processors and Intel® SSDs

Vexata delivers enterprise storage arrays based on Intel® Optane™ SSDs and Intel® PCIe®/NVMe® SSDs to enable transformative application performance for database and analytics workloads.

Executive Summary
Enterprises are recognizing the need for digital transformation to stay competitive, build new business models, and enhance customer experience in this digital economy. High-performance, scalable, and easy-to-deploy application solution stacks are fundamental towards achieving these goals. However, traditional approaches fall short due largely to slow and inefficient storage system architectures that fail to utilize solid-state media effectively for application acceleration. Vexata and Intel have collaborated to solve the digital transformation challenges using a solutions-based approach that brings the best out of applications running on Intel processors using Vexata storage systems that incorporate cutting-edge Intel compute, networking, and storage media technologies.

Digital Transformation Challenges
The IT industry is undergoing a digital disruption, resulting in the need to process higher volumes of data in real time. Enterprise and Cloud native applications are placing significant demands on IT infrastructure. While compute infrastructures based on multi-core processors from Intel enable massive application acceleration, data and storage infrastructures have lagged significantly behind despite major advances in storage media.

Intel offers high capacity, high performance 3D NAND Flash SSDs and Intel® Optane™ SSDs based on the ultra-low latency 3D XPoint™ memory media. However, enterprises have been unable to fully exploit these media for application stack acceleration due to the inefficient architectures of incumbent enterprise storage arrays. Storage array bottlenecks lead to under-utilized database and analytics servers and wasted software licenses. The result? A need for high performance, easy-to-deploy data infrastructures that can enable cloud-scale digital transformation.

Achieving Digital Transformation with Intel and Vexata
Intel and Vexata worked on demonstrating how enterprises can leverage Vexata Scalable Storage Systems and Intel processor-based servers to achieve massive performance, reliability and simplicity for their application workloads. With a differentiated architecture premised on Intel processors and accelerators, Vexata arrays achieve a dramatically higher performance than existing All Flash Arrays through low latency, high-speed parallel access to SSDs.1 By eliminating I/O bottlenecks, Vexata storage systems enable enterprises to achieve transformative performance for their enterprise and cloud-native applications.
Intel® Xeon® Processors and Intel® Optane™ SSD DC P4800X: Fundamental to Vexata's Differentiation

Vexata Scalable Storage Systems deliver over 7M IOPS and up to 85GB/s of mixed read/write bandwidth at ultra low latencies, as low as 40µs. These performance numbers are an order of magnitude better than existing All Flash Arrays and are achievable due to an architecture that is premised on a scalable processor control plane and low-latency Intel® 3D NAND and Intel® Optane technologies. (Figure 1 shows a real 80/20 Oracle workload achieving over 5M IOPS at 40us read latency with a Vexata All Flash Array with Intel® Optane™ SSDs.)

One of the key elements of this architecture is the separation of the control plane from the data plane. All I/O control processes and services are implemented in a CPU-based control plane, and all data processing is offloaded to dedicated hardware. This results in a parallel and wide data access to and from the SSDs at high bandwidth and ultra low latencies.

The Intel® Xeon® processor E5-2697 v4 runs Vexata's Operating System, VX-OS, within the redundant I/O controller. VX-OS is tightly coupled to these cores and utilizes a portion of these cores for I/O control processing, while dedicating other cores for volume services, data reduction, encryption offload control, and so on (Figure 3).

Just as an Oracle database application is able to make use of more processor cores to increase performance, VX-OS is able to utilize the advances in multi-core processor technologies to offer higher performance with greater features.

Intel Components in Vexata Systems

The table below summarizes the key Intel components used in Vexata products to enable ultra-high performance.

<table>
<thead>
<tr>
<th>Compute</th>
<th>Storage Media</th>
<th>Networking</th>
</tr>
</thead>
</table>
| Single socket motherboard with Intel® Xeon® processor E5 v4 with 18 cores (current generation)  
- 7M IOPS with Vexata acceleration  
- Next generation will be Intel® Xeon® Scalable processor with 24 cores or higher  
- 10M IOPS projected with Vexata acceleration |  
- 2TB Intel® SSD DC P3700 Planar NAND  
- 3.2TB, 6.4TB and 12.8TB Intel® SSD DC P4600, 3D NAND, 2.5"  
- 375GB and 750GB Intel® Optane™ SSD P4800X  
- All SSDs enable Vexata arrays to hit ultra low latencies |  
- 2 Intel® 82599 10 Gb Ethernet Controllers  
- DPDK for low latency communication between Vexata I/O Controllers |
Achieving Application Acceleration with Intel® Xeon® Processors and Vexata Systems

The backbone of the digital economy heavily depends on the performance of databases such as Oracle and SQL Server, and analytics platforms such as SAS Analytics. The performance and the efficiency of the underlying data infrastructure is largely premised on using multi-core processors for spreading out application load and the elimination of I/O bottlenecks from the storage subsystem.

Vexata storage systems, coupled with Intel scalable processor-based servers and high-speed Fibre Channel switching enable creation of the industry’s most reliable, efficient, and highest performing application stacks.

The reference design (Figure 4) was used to show application workload performance for Oracle RAC, SAS Analytics and Kx. The results of the benchmarking are shown in Figure 5, along with the advantages of using the Vexata stack.

Hardware Components

<table>
<thead>
<tr>
<th>Hardware Components</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servers</td>
<td>4 or 8 Intel® Xeon® processor E5-2699 v4 servers with 512GB of memory and 4 ports of 32G FC with Broadcom LPe32002-M6* adapters</td>
</tr>
<tr>
<td>Switches</td>
<td>(2) 48-port 32G FC Brocade 620* Switches</td>
</tr>
<tr>
<td>Storage</td>
<td>Vexata VX-100F Flash System with 64 drives of 2TB Intel® SSD DC P3700 (3D NAND Flash memory)</td>
</tr>
</tbody>
</table>

Benchmarking Results

<table>
<thead>
<tr>
<th>Workload</th>
<th>Oracle RAC</th>
<th>SAS Analytics</th>
<th>Kx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server configuration</td>
<td>8 servers with OEL7.2</td>
<td>8 servers with RHAT7.2</td>
<td>4 servers with RHAT7.2</td>
</tr>
<tr>
<td>Software version</td>
<td>Oracle 12c database</td>
<td>SAS Analytics 9.4</td>
<td>Kx kdb+ version 3.5</td>
</tr>
<tr>
<td>Results</td>
<td>5.2M OLTP IOPS at 220us latency</td>
<td>240 sessions at CPU/Real Time ratio of 1.1</td>
<td>36.8GB/s of bandwidth</td>
</tr>
<tr>
<td>Comparison</td>
<td>20x higher than competing All Flash Arrays</td>
<td>12x higher than competing All Flash Arrays</td>
<td>New STAC-M3 records in 8 of 17 Antuco and 14 of 24 Kanaga benchmarks</td>
</tr>
</tbody>
</table>

About Vexata

Vexata’s active data infrastructure solutions enable transformative performance at scale for the I/O intensive applications driving digital business. Based on its groundbreaking VX-OS software, Vexata solid state storage systems deploy simply and seamlessly into enterprise and cloud data center environments. For more information visit vexata.com or follow us @VexataCorp.

About Intel

Intel® Solid State Drives (SSDs) set the standard for storage performance, stability, and efficiency. The Intel® Optane™ SSD DC P4800X helps eliminate data center storage bottlenecks and allows bigger, more affordable data sets. The Intel® Optane™ SSD DC P4800X for the data center can accelerate applications, reduce transaction costs for latency sensitive workloads, and improve overall total cost of ownership (TCO). For more information, visit intel.com/ssd.

1. Benchmarks substantiating the performance differentiations from both internal and external sources (SAS with Intel, ESG, STAC) are published at https://www.vexata.com/resources/
   - Oracle benchmarking used SLOB2 benchmark version 2.3.0.3-1 --> SLOB2 is a benchmark created by EMC solutions for an apply to apply comparison of Oracle performance across different storage arrays. More details at: https://flashdba.com/2013/05/18/slob2-essential-for-every-dba-toolkit/
   - SAS benchmarking was done with the “30 session SAS Mixed Analytics workload”. This is a standard workload from SAS that Intel also has used many times. See link below to Intel document: https://www.intel.com/content/dam/www/public/us/en/documents/infographics/faster-sas-analytics-for-transformative-results-infographic.pdf

Intel technologies’ features and benefits depend on system configuration and may require enabled hardware, software or service activation. Learn more at intel.com, or from the OEM or retailer.

Benchmark results were obtained prior to implementation of recent software patches and firmware updates intended to address exploits referred to as “Spectre” and “Meltdown”. Implementation of these updates may make these results inapplicable to your device or system.

Tests document performance of components on a particular test, in specific systems. Differences in hardware, software, or configuration will affect actual performance. Consult other sources of information to evaluate performance as you consider your purchase.

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