SOLUTION BRIEF

Cloud Service Providers
Intel® Optane™ Technology

At Last, Big, Affordable Memory for Cloud Providers

Intel® Optane™ SSD DC P4800X offers an affordable alternative to DRAM for maintaining performance and expanding memory

Intel® Optane™ DC SSDs with Intel® Memory Drive Technology actively manage data transfers between the DRAM and the SSD, providing exceptional capacity and performance.

Executive Summary

For many cloud customers with memory-consuming workloads, performance goes beyond the CPU and system performance, and is often dependent on memory (bandwidth and capacity). For these memory-consuming workloads, the Intel® Optane™ SSD DC P4800X with Intel® Memory Drive Technology provides additional options beyond traditional DRAM DIMMS; these options are expanding total memory even beyond the DIMM capacity. It also offers a less expensive alternative for DRAM DIMM replacement.

The Intel Optane SSD DC P4800X provides an affordable alternative to expensive DRAM without sacrificing performance. Now cloud providers with Linux*-based data centers using kernel-based virtual machine (KVM) can offer more competitively priced solutions without compromising performance or expanding memory pools to meet higher demanding workloads.

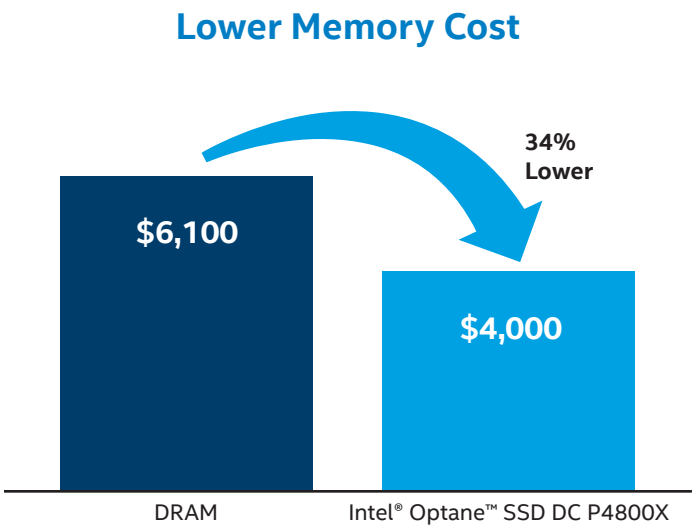

Figure 1. Intel® Optane™ SSD DC P4800X provides an affordable alternative to DRAM.[1]

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Solution Benefits

This solution offers the following benefits:

- **Expand beyond DRAM capacity.** Intel® Optane™ DC SSDs expand memory pools while maintaining comparable performance to DRAM.[2]
- **Provides an affordable alternative.** Intel Optane DC SSDs use the less expensive alternative/replacement while retaining performance.[3]
- **Plug-n-play.** The solution seamlessly manages memory without modifications to code, applications, or the operating system.

Business Challenge: Big Memory Can Be Too Costly

In today's competitive market, cloud providers need memory solutions that are more affordable, but that do not sacrifice performance. DRAM is expensive, and many flexible workloads do not require its full bandwidth and latency capabilities. These workloads include analytics, iterative statistical models, and high-performance batch processing for artificial intelligence (AI). Using high-endurance storage solid state drives (SSDs) to expand memory on virtualized nodes can reduce the total cost, but traditional NAND-based SSDs require more work from the controller to ensure wear leveling, which can lead to over-provisioning also due to limited media endurance.

Intel® Optane™ DC SSDs provide a solution that allows data centers running Linux* and kernel-based virtual machine (KVM) to turn storage into memory transparently.

Use Cases: Choose Between Expanded Capacity or Reduced Cost

Using an Intel® Optane™ SSD DC P4800X with Intel® Memory Drive Technology makes it simple to seamlessly manage the memory pool.[4] It does not require any modifications to hardware, software, or the operating system.

Additionally, Intel Optane DC SSDs enable cloud providers to gain two new strategies to help meet customer needs. Whether competing on price, performance, or both, the options include:

- **Expanding memory.** Expand memory capacity beyond the DRAM limit to gain better insights into massive data pools.[2]
- **Lowering cost.** Displace expensive DRAM with much more affordable Intel Optane DC SSDs without significantly degrading performance.[3]

Solution Value: Affordable Performance that Is Easy to Manage

Using a fraction of the DRAM, Intel Optane DC SSDs with Intel Memory Drive Technology deliver transparent software-defined memory that performs similarly to big DRAM environments. Without requiring software or hardware changes, data centers can grow beyond system DRAM capacity or choose to replace high-capacity DIMMs for lower cost.

In cost and performance testing, we compared KVM with Intel Optane DC SSDs versus all-DRAM configurations using Redis* datastores.[5] We found the following results (see Figure 2):

- **Similar size memory pool.** The available memory was consistent across both environments.
- **Same performance.** Both environments processed 5,000 transactions per second (TPS)/VM.[2]
- **About 30 percent lower costs.** The cost of an all-DRAM environment was approximately USD 6,100[1] and the Intel Optane DC SSD environment cost approximately USD 4,000—a 34-percent cost savings.[1]

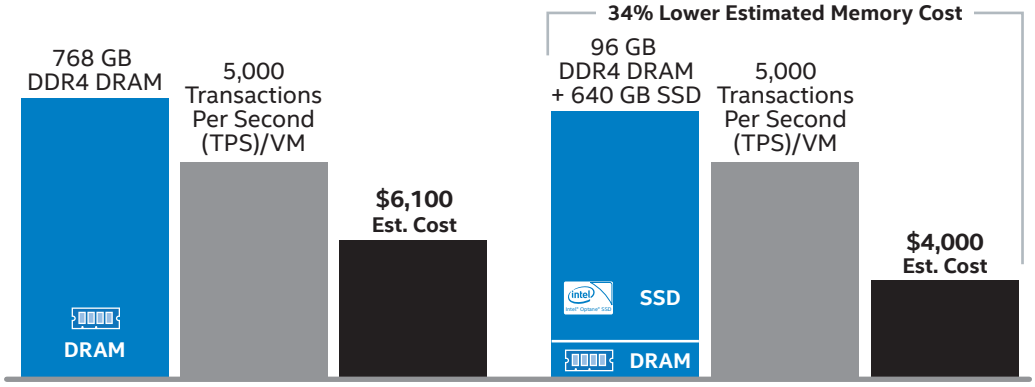


Figure 2. Kernel-based virtual machine (KVM) with Intel® Optane™ DC SSDs cost 34 percent less than all DRAM[1] while maintaining a similar memory pool size and the same performance[2] overall.

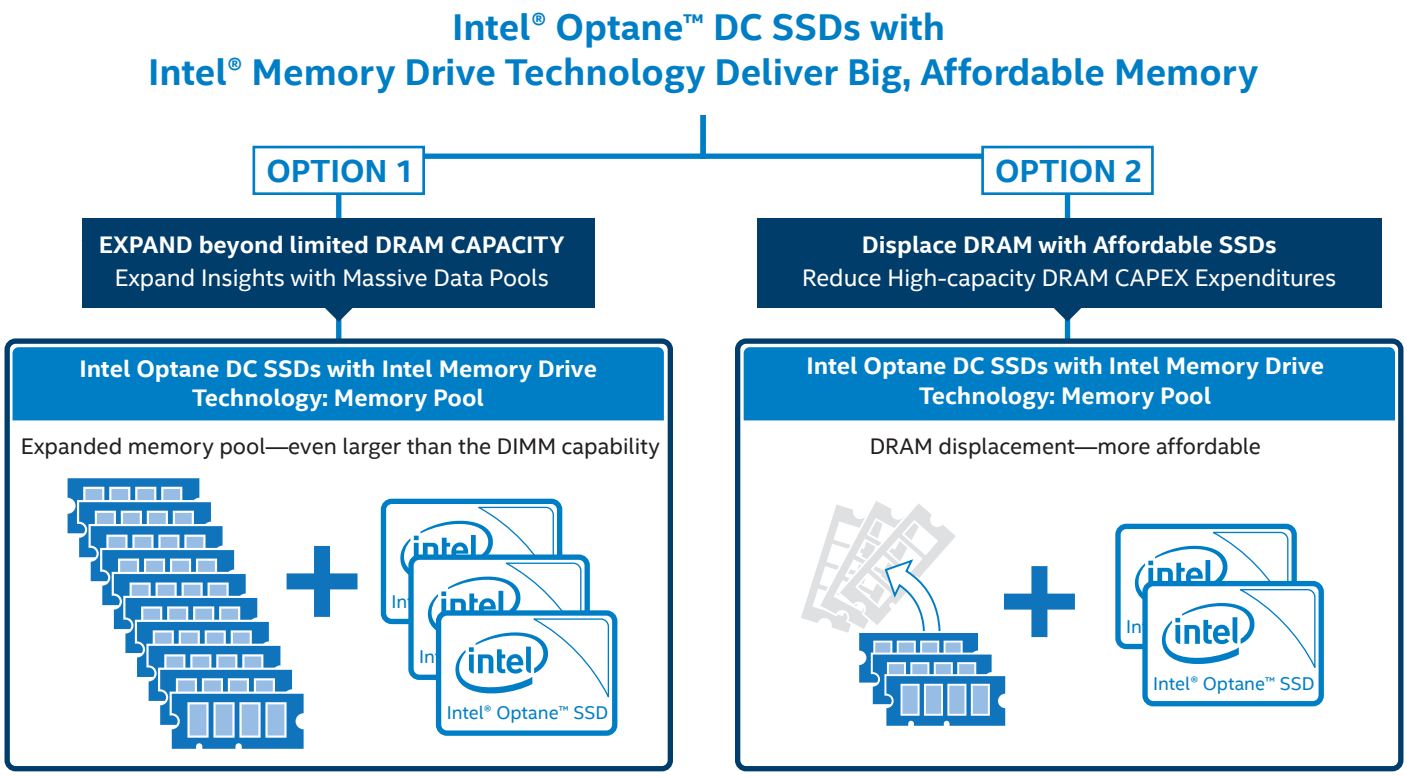


Figure 3. Intel® Optane™ DC SSDs offer flexibility to expand beyond the limits of DRAM or to displace expensive DRAM for more affordable computing with similar performance.[2]

Solution Architecture: Highly Responsive Read/Write Performance

The Intel Optane SSD DC P4800X uses revolutionary media, making it highly responsive, especially for mixed read/write workloads. Data can be written in place, eliminating write amplification and significantly improving endurance for the most demanding workloads.

Intel Optane DC SSDs with Intel Memory Drive Technology in the middle layer and DRAM present a single memory pool that is completely transparent to the operating system and other software. Displace expensive DRAM with more affordable Intel Optane DC SSDs without degrading performance (see Figure 3). Intel Optane DC SSDs with Intel Memory Drive Technology actively manage data transfers between the DRAM and the SSD, providing optimal capacity and performance.

Conclusion

Linux-based data centers running KVM no longer need to rely solely on expensive DRAM to deliver performance. With Intel Optane SSD DC P4800X, cloud providers can expand existing memory pools for more computing or displace DRAM to realize lower costs without sacrificing performance.

This solution is particularly well-suited to flexible workloads, such as analytics, high-performance AI batch workloads, and iterative statistical models.

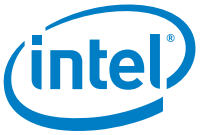
Performance testing between all-DRAM environments and environments with Intel Optane DC SSDs and system DRAM indicated consistent performance[2] and comparable memory pools at 34 percent lower cost.[1]

Find the right solution for your organization. Contact your Intel representative or visit **intel.com/optane**.

Learn More

You may also find the following resources useful:

- Intel® Memory Drive Technology
- The Age of Data Center Convergence Gives Storage a Boost
- Adding Intel® Optane™ DC SSDs to VMware vSAN* Data Storage Increases Performance While Reducing Costs paper
- Intel Resources for Cloud Service Providers



[1] Source – Intel® Optane™ Technology: Turning Storage into Memory Affordably (digitallibrary.intel.com/content/solutions/us/en/assetdetail.html/content/dam/solutions/nsg-solution-kit-kvm-solution-overview.pptx); March 2019, Slide 15: KVM + REDIS* Memory Cost Comparison vs All-DRAM; Up to 34% Lower Estimated Memory Cost. Detailed information on this option can be found in the Set Up and Configuration Guide: intel.com/content/dam/support/us/en/documents/memory-and-storage/intel-mdt-setup-guide.pdf

[2] Source – Intel® Optane™ Technology: Turning Storage into Memory Affordably (digitallibrary.intel.com/content/solutions/us/en/assetdetail.html/content/dam/solutions/nsg-solution-kit-kvm-solution-overview.pptx); March 2019, Slide 15: KVM + REDIS* Memory Cost Comparison vs All-DRAM; REDIS Request Transactions Per Second. Detailed information on this option can be found in the Set Up and Configuration Guide: intel.com/content/dam/support/us/en/documents/memory-and-storage/intel-mdt-setup-guide.pdf

[3] Source - System Memory at a Fraction of the DRAM Cost White Paper, page 4: intel.com/content/dam/www/public/us/en/documents/brief/intel-ssd-software-defined-memory-with-vm.pdf. Note: Cost reduction scenarios described are intended as examples of how a given Intel-based product, in the specified circumstances and configurations, may affect future costs and provide cost savings. Circumstances will vary. Intel does not guarantee any costs or cost reductions.

[4] Source: Set Up and Configuration Guide, January 2019, Section: 9.4.1 Large Memory Compute Intensive Workload, see Appendix A for test set up. Performance results are based on testing as of January 2019 set forth in the Configurations and may not reflect all publicly available security updates. See configuration disclosure for details. No product can be absolutely secure. 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 intel.com/benchmarks. For full test set up details visit: intel.com/content/dam/support/us/en/documents/memory-and-storage/intel-mdt-setup-guide.pdf.

[5] Source – Intel: Server base configuration: 2x Intel® Xeon® Gold 6154 processor @ 3.00 GHz; Network topology: 10GigE dedicated back-to-back link; CentOS Linux* release 7.4 (Core); Kernel: 3.10.0-693.5.2 (el7.x86_64); BIOS: SE5C620.86B.00.01.0014.070920180847.All-DRAM configuration: Server Base configuration +768 GB DRAM. Intel® Optane™ Configuration: Server Base configuration + 96 GB DRAM and 2 – 375 GB Intel® Optane™ DC P4800 X SSDs. Testing date: August 14, 2018.

Performance results based on testing as of August 14, 2018 and may not reflect all publicly available security updates. See configuration disclosure for details.

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