FAQ

Intel Data Center Memory and Storage FAQ
April 2019

Intel® Optane™ DC Technology Frequently Asked Questions (FAQ)

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Introduction to Intel® Optane™ DC Technology

As data constantly changes and expands, data centers increasingly face capacity, performance, and cost limitations related to existing memory and storage solutions. Intel® Optane™ data center (DC) technology addresses these challenges by placing data closer to the CPU and closing the gap between traditional memory and storage options, thus transforming the memory and storage tier. This document answers some frequently asked questions (FAQs) from IT administrators and professionals about this new and exciting technology, along with its data center products. For additional information, go to intel.com/Optane

Intel® Optane™ DC Technology and Products FAQ

General Technology

Q: What is Intel® Optane™ technology?

A: Intel Optane technology is the unique combination of Intel® Optane™ memory media with Intel's advanced system memory controller, interface hardware, and software IP. Intel Optane technology is offered on a variety of client and data center form factors to unleash vast system-performance potential in a range of products.

The first new technology of its type in 25 years, Intel Optane technology revolutionizes computer architecture for clients, workstations, and servers, delivering new value to users around the world. This new technology creates an inflection point in how PCs, workstations, and data centers are redesigned and re-engineered. Its industry-leading combination of low latency, high endurance, high quality of service (QoS), and high throughput allows the creation of solutions that remove data bottlenecks, thus unleashing CPU utilization and opening myriad possibilities across uses and industries.

Q: What is the primary technology behind Intel Optane technology, and is it susceptible to the same shortage issues as other types of solid-state drives (SSDs)?

A: The primary technology underlying Intel Optane technology products is a new memory and storage media that is inherently different from NAND. It is transistor-less and bit-addressable, faster and more durable, and avoids many shortcomings of NAND drives. Intel Optane memory media architecture allows Intel Optane technology to act like DRAM (byte addressability, high endurance, write in place) or traditional storage (block addressability), depending on the use case or product form factor.

Q: How is Intel Optane technology different from Intel Optane memory media?

A: Intel Optane memory media is the underlying memory that makes up Intel Optane technology when it is combined with Intel® advanced system memory controllers, interface hardware, and software IP.

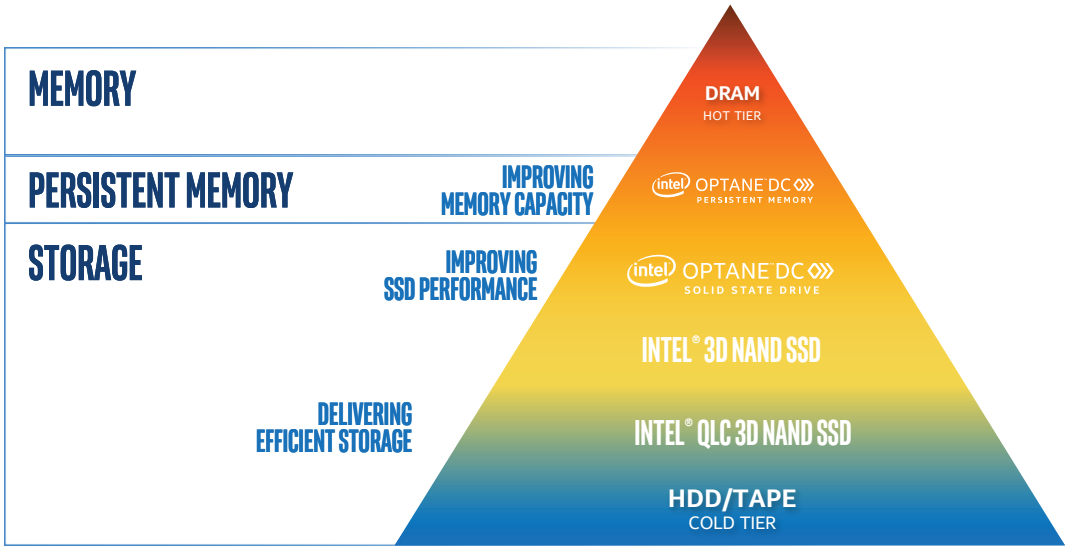
Q: What are other similar or competitive technologies?

A: We are not aware of any direct competitive products or technologies at this time. Our technology is a new approach and is the first breakthrough of its kind in memory technology in 25 years. We do expect the competition to follow our lead on storage-class memory. We have been working for 10 years on Intel Optane technology, and we have worked through the hard issues of going from building one cell, to an array of cells, to high volume manufacturing.

Intel® Optane™ DC Technology in Existing Environments

Q: When will memory and storage converge?

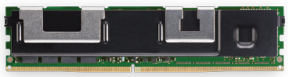
A: We see memory and storage as a continuum, with different products and capabilities addressing different needs. Prior to Intel® Optane™ technology, businesses faced large gaps in the memory-storage hierarchy. Intel Optane technology fills those gaps by expanding memory capacity, adding persistence, and offering high-performance, low latency SSDs to fill out the enterprise data center toolkit. Today, data center and system architects can optimize applications and workloads by making use of the full range of memory and storage options available to them.



Q: Why is Intel Optane technology referred to as flexible?

A: The underlying architecture of Intel® Optane™ memory media gives it the flexibility to be used in different form factors, each with its own set of hardware controllers, interconnects, and software IP. Table 1 shows three different memory and storage products built on Intel Optane technology.

Table 1. Comparison of memory and storage: Intel® Optane™ DC persistent memory DIMMs and Intel® Optane™ DC SSDs

	Intel® Optane™ DC Persistent Memory 	Intel® Optane™ DC SSD with Intel® Memory Drive Technology 	Intel® Optane™ DC SSD 
Interface	Memory Channel	PCIe* Bus	PCIe Bus
Capacity	Up to 512 GB per DIMM	Up to 1.5 TB per SSD	Up to 1.5 TB per SSD
Intel Platform	2nd Generation Intel® Xeon® Scalable processor	Any	Any
Function	App Direct Mode: Persistent Memory Memory Mode: Volatile Memory Storage Over App Direct Mode: Persistent Storage	Volatile Memory	Persistent Storage
Form Factor	DIMM	U.2, M.2, AIC	U.2, M.2, AIC
Operating System	Windows*, Linux*, VMware ESXi*	Linux	Any

Q: With this new technology, won't OEMs have to retrofit their hardware? Have they done so yet?

A: Intel® Optane™ DC SSDs can be used with any system that accepts PCIe*-based SSDs. Intel Optane DC persistent memory modules will fit in standard memory channel DIMM slots, but it will require systems built with 2nd Generation Intel® Xeon® Scalable processors and with the supporting Intel® memory controllers.

Q: Will software vendors need to rewrite applications to work with this new technology?

A: When Intel Optane technology is accessed as storage or as volatile memory in Memory Mode, no software modifications are needed. To get the maximum benefits of Intel Optane DC persistent memory, including non-volatility, applications require modification to access Intel Optane DC persistent memory in App Direct Mode. Many major software vendors, including SAP, have already updated applications to support persistent memory. We encourage software vendors to update their applications to unleash the full capabilities of Intel Optane technology.

Q: How will data center infrastructures benefit from Intel Optane DC technology?

A: Intel Optane DC technology unleashes new potential for data centers to optimize their infrastructures to meet their specific memory and storage needs. In some cases, this could lead to a better overall cost structure. From Intel® QLC 3D NAND drives to Intel Optane DC SSDs to Intel Optane DC persistent memory to DRAM, Intel storage technologies and products offer data center architects flexibility to match performance, capacity, reliability, and affordability to their business applications and workloads. (To learn more, read the technology briefs "Reimagining Memory and Storage in the Data Center" and "Intel® Optane™ Technology: Memory or Storage? Both.")

Q: How does Intel Optane DC technology fit into the data center family alongside the Intel® SSD D5-P4320 and Intel SSD D5-P4326?

A: Intel Optane technology complements Intel QLC 3D NAND SSDs. Deploying Intel Optane DC SSDs together with Intel QLC 3D NAND SSDs provides both performance and capacity. Intel Optane DC SSDs provide high input/output operations per second (IOPS), low latency, and high endurance for heavy write workloads, whereas Intel QLC 3D NAND SSDs can provide total cost of ownership (TCO) value via lower costs and high density for large-capacity storage. Intel Optane DC SSDs are best suited to address input/output (I/O); Intel QLC 3D NAND SSDs are best suited for large-capacity storage. When used together in a data center, IT operators can better tune their systems to gain optimal efficiency based on different workloads using different media.

Q: Is Intel Optane technology well suited for Windows Server* storage environments?

A: Intel Optane DC SSDs work great in Windows Server storage environments. Microsoft has a public demonstration of a Window Server Storage Spaces Direct storage system with over 13M IOPS using Intel Optane DC SSDs.[1]

Q: Why should I buy Intel QLC 3D NAND SSDs instead of Intel Optane DC SSDs, if Intel Optane technology will be faster?

A: With the introduction of Intel Optane DC technology, data center architects now have the flexibility to combine memory and storage products into an optimized architecture for their workloads and applications. For example, Intel QLC 3D NAND SSDs offer a great price/performance ratio for capacity storage. Intel Optane DC SSDs are ideal as a fast-caching storage layer for hot data that can be combined with a much larger 3D NAND capacity tier. The two work together to provide high performance at an excellent value.

Q: Do Intel Optane DC SSDs have the same read/write longevity issues as standard SSDs?

A: No; in fact, they are high endurance. A high-end enterprise NAND SSD typically supports 3 drive writes per day (DWPD) for 5 years, whereas Intel Optane DC SSDs support up to 60 DWPD for 5 years.[2] Note that SSDs don't have endurance problems with reads; only writes cause endurance issues.

Q: What controllers do Intel Optane DC SSDs use?

A: Intel Optane DC SSDs and Intel Optane DC persistent memory will utilize controllers developed by Intel specifically for Intel Optane technology. The new generation of Intel controller was architected from the ground up to take advantage of Intel Optane technology. It was designed around the unique and exciting capabilities of Intel Optane memory media: low latency, high QoS, high throughput, and high endurance.

Q: Is the I/O performance of Intel Optane DC SSDs on par with NAND-based SSDs/solutions? Why should users spend more to get the same performance?

A: Intel Optane technology is superb for random workloads at low queue depths, which is where the majority of activity occurs in real use cases. Additionally, Intel Optane technology is fast all the time—that is, even under load, Intel Optane technology maintains excellent low-latency performance under the worst-case conditions.

Q: Is Intel Optane technology going to be implemented in storage-area networks (SANs), or is it already?

A: Yes, it can be implemented in a SAN environment, including a virtual SAN (VSAN) environment. It is typically used as a fast caching tier on top of a larger raw-capacity tier. In addition, we have just announced the new dual port Intel Optane SSD DC D4800X drive. Dual port drives are typically used in storage arrays that make up the bulk of enterprise SAN deployments today.

Q: With Intel Optane DC SSDs and Intel Optane DC persistent memory, what are the minimum power-supply requirements?

A: Power-supply specifications vary based upon capacity, form factor, and quantity, among other variables. Product specs are posted on https://ark.intel.com.

Q: What are the actual benefits that people will see with this new technology?

A: For constrained workloads, people typically see an overall performance improvement of their entire system with Intel Optane DC technology. Generally, Intel Optane DC SSDs accelerate storage-constrained systems and Intel Optane DC persistent memory accelerates memory-constrained systems. With the acceleration provided by Intel Optane DC technology, the previously constrained systems can perform with greater efficiency.

Intel® Optane™ SSD DC P4800X

Q: What is the difference between the Intel® Optane™ SSD DC P4800X and the Intel® SSD DC P4500/P4600?

A: Intel SSDs can be used across a continuum of data tiering needs including storage, caching, and memory. Intel Optane SSD DC P4800X and Intel SSD DC P4500/P4600 drives have different benefits based on where and how you use them. Generally speaking, Intel Optane SSD DC P4800X drives are used for system acceleration, whereas Intel SSD DC P4500/P4600 drives are used for bulk data.

Storage

The storage tier is about storing massive amounts of permanent data effectively. The dense concentration of performance and capacity of Intel SSD DC P4500/P4600 drives enable cost-effective storage of massive volumes while helping reduce cost and improve server agility.

Caching

Both Intel Optane SSD DC P4800X drives and select Intel SSD DC P4500/P4600 drives can be used for caching. The best NVM Express* (NVMe*) caching SSDs are PCIe*-based and can significantly accelerate applications and increase server utilization beyond a Serial ATA (SATA) SSD device. However, with some applications, even the performance of a NAND SSD might not be sufficient and could bottleneck performance and capacity scaling. In these cases, an Intel Optane SSD DC P4800X is the better solution.

Memory

Intel Optane SSD DC P4800X drives' breakthrough performance, predictably fast QoS, and endurance allow them to extend the size of memory pools. This enables larger working datasets (more data close to the CPU) to help realize new data-driven value.

Q: What applications are best served by an Intel Optane SSD DC P4800X? What workloads?

A: Highly random, storage-bound applications are best served by the Intel Optane SSD DC P4800X. Intel Optane DC SSDs are ideal for working and real-time data stored in large volumes. The Intel Optane SSD DC P4800X allows each server to do more across applications.

Q: How does the Intel Optane SSD DC P4800X fit into the modern data center? What about the next-generation data center?

A: The Intel Optane SSD DC P4800X can be used to accelerate any workload that requires low latency and high QoS. It also delivers industry leading performance at low queue depths. We see the Intel Optane SSD DC P4800X fitting into the evolving data center in two ways: one, as fast storage or cache, and two, as a memory-pool extension.

As fast storage or cache, the drive delivers fast performance that can break through storage bottlenecks and significantly increase scale per server while reducing the transaction costs of latency-sensitive workloads. And, when configured with Intel® Memory Drive Technology, the Intel Optane SSD DC P4800X can be deployed to enable bigger, more cost-effective memory.

Read the Intel Optane SSD DC P4800X product brief for more information.

Intel® Optane™ SSD DC D4800X

Q: What is the Intel® Optane™ SSD DC D4800X?

A: The dual port-enabled Intel Optane SSD DC D4800X combines the performance of Intel Optane DC SSDs with the data resilience required by critical high-availability enterprise IT applications. Dual port capabilities add redundancy to the data path to deliver continued data access in the event of failures or service operations and upgrades.

Q: What segments and usages are best served by the Intel Optane SSD DC D4800X?

A: Enterprise high-availability storage environments, such as reservation systems and banking, require 24/7 data access. These applications are also looking for more performance to accelerate application performance and deliver higher service levels. With Serial-Attached SCSI (SAS) dual port drives running out of performance headroom, this is where the performance of Intel Optane DC SSDs shines.

Q: How does the Intel Optane SSD DC D4800X work with Intel Optane DC persistent memory?

A: These devices play a complementary role in enterprise high-availability solutions. The Intel Optane SSD DC D4800X breaks through the SAS dual port cache bottleneck. Certain applications can benefit from the larger memory footprint, affordability, and persistence of Intel Optane DC persistent memory.

Intel® Optane™ DC Persistent Memory

Q: What is Intel® Optane™ DC persistent memory?

A: Intel Optane DC persistent memory is a memory technology that delivers high-performance intelligence, is byte-addressable, offers higher capacity than DRAM at lower cost, and, unlike DRAM, it can retain its data even when power is off.

Q: What Intel® Optane™ memory media and other Intel innovations come in a DIMM form factor for data center platforms?

A: In April 2019, we highlighted a new performance capability showing that Intel Optane DC persistent memory–based systems can achieve performance gains compared to configurations relying on DRAM only. For the latest proof-point details, please reference the launch disclosures.

Q: Can Intel® Optane™ technology replace DRAM?

A: Intel Optane DC persistent memory augments DRAM to expand system memory well beyond what is possible from DRAM alone.

Q: Can you explain the value of Intel Optane DC persistent memory modules compared to DRAM?

A: Unlike DRAM, Intel Optane DC persistent memory is non-volatile and retains data across power cycles. This can enhance performance because applications don't have to wait for data to be written out to the disk to be made permanent, and it can shorten restart times because data does not have to be retrieved from disk to get the service operational again. That's particularly important for large, in-memory databases where uptime is critical. Intel Optane DC persistent memory can provide affordable, large-memory capacities with native persistence in module sizes up to 512 GB, which is 4x larger than the 128 GB DDR4 DIMMs available today. We expect to offer persistent memory at a lower cost-per-GB than equivalent quantities of DRAM. Fundamentally, applications that have been optimized to take advantage of the persistent nature of Intel Optane DC persistent memory are able to write data to persistent storage at memory speeds, rather than storage speeds. This means orders-of-magnitude lower latency and significant increases in execution efficiency.

Q: Can you talk about the use cases for persistent memory and when we'll see support from major software vendors?

A: Some of the initial use cases for persistent memory include more cost-effective in-memory databases, greater virtual-machine (VM) and container density, more efficient distributed cloud services, higher database performance, high-performance storage, and faster restart times. Software vendors that have stated their support or publicly demonstrated interest in persistent memory include Aerospike*, Apache Cassandra*, GigaSpaces*, Java*, KVM*, Microsoft*, Oracle*, Red Hat*, Redis*, RocksDB*, SAP*, SUSE*, and VMware*. We continue to engage Intel's unmatched global ecosystem to deliver solutions in alignment with our development milestones.

Q: How does Intel Optane technology work with in-memory databases?

A: Applications that have been optimized for Intel Optane DC persistent memory avoid the significant software overhead of I/O operations and instead benefit from much faster low-latency memory-access operations. This advantage enables organizations to transform their systems and services to deliver new advancements across a wide range of data center use cases, including improved analytics with in-memory databases and high-performance in-memory computing. Intel Optane DC persistent memory can also significantly reduce in-memory database restart times because the database does not have to be reloaded into volatile memory after a shutdown. And with Intel Optane DC persistent memory, organizations can more affordably scale system memory capacity to unprecedented levels because the cost per gigabyte of memory is lower with Intel Optane DC persistent memory modules, compared to traditional DRAM DIMMs.

Q: How long do you think it will take for this software optimization to occur?

A: It's happening now. Intel Optane DC persistent memory software optimization work started in 2018 and continues as more companies take advantage of the technology's capabilities.

Q: In a server such as SQL, how does this technology scale for large databases?

A: It's actually not a question of the size of the database, but rather the response time (latency) of the database and the transactions per second delivered to the organization. Intel Optane technology can greatly reduce the time to data delivery with low latency and a consistent response time—even under load. This is why we look at Intel Optane DC SSDs as system accelerators. Large databases historically have been unable to fit into memory, but Intel Optane technology can greatly increase a system's possible memory size without the limitations of DRAM. Uniquely, and most importantly, because Intel Optane DC persistent memory is persistent, applications can be optimized to take advantage of the persistency of storage with the access of memory, which can greatly increase performance.

Intel® Optane™ DC SSDs Working with Intel Optane DC Persistent Memory

Q: How do I know when to use the Intel® Optane™ SSD DC P4800X with Intel® Memory Drive Technology compared to Intel Optane DC persistent memory?

A: Intel will provide a variety of solutions based on Intel® Optane™ technology to deliver the best end-user value, experience, and choice. Intel Optane DC persistent memory can offer the best performance due to the DIMM interface providing lower latency, higher bandwidth, and a memory-access schema (byte versus block). This solution enables systems to take advantage of the non-volatile nature of Intel® Optane™ memory media through the implementation of persistent memory schemes. Intel Optane DC SSDs with Intel Memory Drive Technology provide options that are available today, as well as additional choice to scale to greater memory pools within a server with the PCIe* and NVMe* interface (as opposed to the memory-channel DIMM interface). Intel Optane DC SSDs with Intel Memory Drive Technology use middleware software that enables transparent application support on platforms with 2nd Generation Intel® Xeon® Scalable processors.

Q: Is Intel Optane DC persistent memory ready to replace my SAN?

A: No, but Intel Optane DC SSDs can help as the caching tier, not the raw-capacity tier.

Q: How does the Intel Optane SSD DC P4800X work with the forthcoming DIMMs based on Intel Optane memory media?

A: We are building a portfolio of solutions to support a wide range of data center needs—including solutions to meet performance, persistence, affordability, capacity, or form-factor requirements. An Intel Optane memory media–based DIMM, directly attached to the CPU, can provide the best performance, lowest latency, and highest throughput, along with a persistent memory solution. The Intel Optane SSD DC P4800X delivers low latency and high throughput in an SSD implementation with the PCIe and NVMe interface.

Q: Do Intel Optane DC SSDs and Intel Optane DC persistent memory compete with each other? Aren't they both striving for the same use cases in many situations?

A: In most cases, the benefits and uses of the two products are very different. There are a handful of use cases where a customer could make a choice between the two based on specific balancing of performance and cost. There are also use cases in which Intel Optane DC SSDs and Intel Optane DC persistent memory can be combined to deliver on customer data-performance requirements. As an example, the Intel Optane SSD DC P4800X can be used as a fast-cache storage tier in combination with Intel Optane DC persistent memory. Intel Optane DC persistent memory works only on 2nd Generation Intel Xeon Scalable processors, whereas Intel Optane DC SSDs can be used with multiple platform generations, including 2nd Generation Intel Xeon Scalable processors and previous-generation Intel Xeon Scalable processors.

For more information, go to intel.com/Optane

[1] Microsoft. "Demo - Windows Server 2019 with Intel Optane DC persistent memory." October 2018. youtube.com/watch?v=8WMXkMLJORc.

[2] Intel. "Product Brief: Intel® Optane™ SSD DC P4800X/P4801X Series." intel.com/content/www/us/en/solid-state-drives/optane-ssd-dc-p4800x-brief.html.

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 reduction.

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