

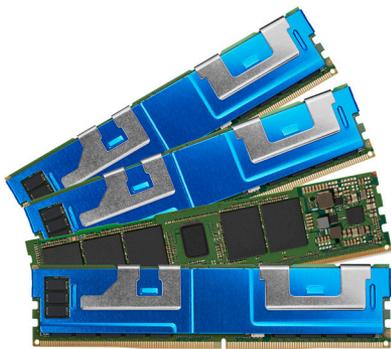
Product Brief

Data Center
Intel® Optane™ Persistent Memory 200 Series



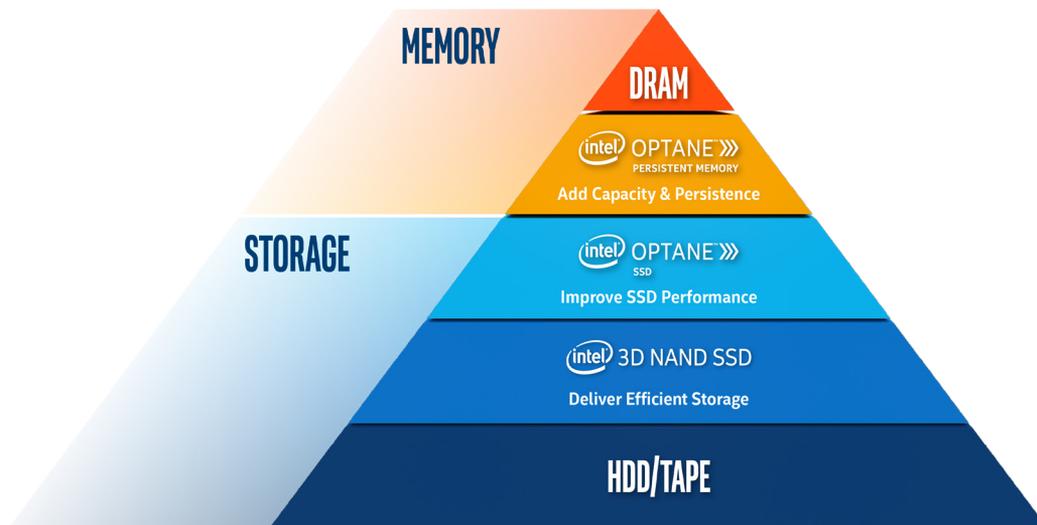
Putting More of Your Data to Work is Now Easier Than Ever

Intel® Optane™ Persistent Memory 200 Series Delivers on Average 25% More Bandwidth¹ with up to 4.5 TB Total Memory per Socket



Over 90% of enterprises are in the midst of their digital transformation journey² to become data-centric businesses with requirements to capture, analyze, and secure increasing amounts of data. This is accelerating the demand for compute and driving the need for more data to be processed closer to the CPU. DRAM memory offers low latency but is limited in capacity, expensive, and volatile. Block storage is large, cheap, and persistent, but slow to access. Intel® Optane™ persistent memory (PMem) bridges the gap with an innovative memory technology that delivers a unique combination of affordable large capacity and support for data persistence.

Intel Optane PMem 200 series is the second generation of a high performing persistent memory tier optimized for 3rd Gen Intel® Xeon® Scalable processors that helps turn data into actionable insights. Intel Optane PMem 200 series delivers an average of 25% more memory bandwidth than the previous generation¹, 12-15 watts of thermal design power (TDP) and is available in capacities up to 512 GB. Additionally, it is compatible with the software ecosystem already established for Intel Optane persistent memory.





Intel Optane Persistent Memory 200 Series

Intel Optane PMem 200 series modules are supported on 3rd Gen Intel Xeon Scalable processors and create a high-performing, large-capacity persistent memory tier that helps turn more data into actionable insights. Intel Optane PMem 200 series is available in 128 GB, 256 GB, and 512 GB modules and coexist with traditional DDR4 DIMMs, occupying the same motherboard slots side-by-side with DRAM. A platform optimized for these next-generation processors can support one Intel Optane PMem 200 series module per channel (up to six on a single socket), providing up to 3 TB of PMem per socket and total memory capacity of 4.5 TB per socket. Intel Optane PMem 200 series is compatible with the software ecosystem established for Intel Optane persistent memory for workloads, such as databases, analytics, and virtualized infrastructure.

Data Persistence for Memory

Unlike DRAM, data remains in PMem after a planned or unplanned restart, avoiding time-consuming data reloads, which means less down time, fewer losses from system outages, and increased operational efficiency. Developers can utilize the industry standard persistent memory programming model to build simpler and more powerful applications to future-proof their data center investment.

Secure Data at Rest

The Intel Optane PMem 200 series integrates strong, industry-standard hardware security encryption measures for data at rest. Application-transparent AES-256 encryption secures all data at rest in persistent memory with no software code changes and minimal impact on performance.

Affordable Large Capacity

Intel Optane PMem 200 series enables more value to be extracted from larger data sets and increases the utility of each server. In-memory databases can access more data at DRAM-like speeds, and workloads processing massive data

Create a high-performing, large-capacity persistent memory tier with Intel Optane PMem 200 series to improve key data center metrics such as:

- Increased CPU utilization and utility of each server
- Increased application throughput with more memory capacity
- Increased VM density or support more services and users
- Support for larger in-memory databases without prohibitive price tags
- Improve business resilience for systems with critical data
- Consolidate server footprint, reduce software licensing costs, and maximize return on your enterprise investment

sets, such as scientific or data warehousing and analytics, can work continuously without repeatedly loading and storing data locally. Additionally, Intel Optane PMem can offer greater memory capacity per socket than DRAM for virtualized data center infrastructures, leaving more headroom for virtualizing future workloads requiring larger memory capacity rather than having to run those demanding workloads on bare metal.

When deployed, Intel Optane PMem 200 series can enable you to consolidate and reduce your server footprint, leading to lower software licensing costs, reduced power consumption, and other operational efficiencies.

What Challenges Does Persistent Memory Address?

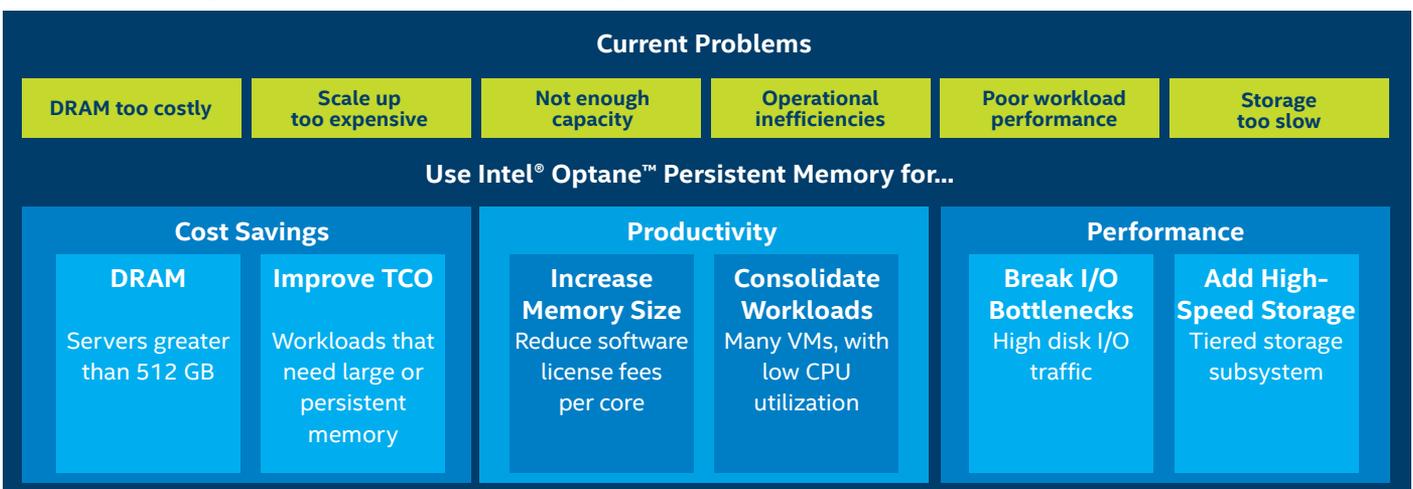


Figure 1. Intel Optane PMem 200 series solves several key challenges in computing today.

Operational Modes

Intel Optane PMem 200 series has multiple operating modes:

Memory Mode – Memory Mode delivers large memory capacity without application changes and with performance close to that of DRAM, depending on the workload. In Memory Mode, the CPU memory controller sees all of the Intel Optane PMem 200 series as volatile system memory (without persistence), while using the DRAM as cache. In Memory Mode, data in the modules is protected with a single encryption key that is discarded upon power down, making the data inaccessible.

Memory Mode's large capacity enables more VMs and more memory per VM at a lower cost compared to DDR4 DIMMs. Workloads that are I/O bound can also benefit from using Intel Optane PMem 200 series in Memory Mode, because the larger memory capacity supports bigger databases at a lower cost compared to DDR4 DIMMs. With increased capacity there is greater VM, container, and application density, which increases the utilization of 3rd Gen Intel Xeon Scalable processors.

App Direct Mode – App Direct Mode enables large memory capacity and data persistence for software to access DRAM and persistent memory as two tiers of memory.

In App Direct Mode, software and applications enabled for the industry standard NVM persistent memory programming model have the ability to talk directly to PMem, reducing the complexity in the stack and taking full advantage of byte-addressable persistent memory with cache coherence, which extends the usage of persistent memory outside the local node, and provides consistent low latency, supporting larger datasets.

App Direct Mode can also be used with standard file APIs to access the same persistent memory address space (called Storage over App Direct) without any modifications to the existing applications or the file systems that expect block storage devices. Storage over App Direct presents Intel Optane PMem as high-performance block storage, without the latency of moving data to and from the I/O bus.

In App Direct Mode, data is encrypted using a key stored on the module in a security metadata region, which is only accessible by the Intel Optane PMem 200 series controller. The modules are locked at power loss, and a passphrase is needed to unlock and access the data. If a module is repurposed or discarded, a secure cryptographic erase and DIMM over-write operation keeps data from being accessed.

Drive Application Innovation and Explore New Data-Intensive Use Case with this Best-in-Class Product

With Intel Optane PMem 200 series, developers have direct load/store access to it and can drive new innovation and capabilities using the same persistent programming model introduced with the first generation of PMem. Rapid adoption is easy, and customers are able to take full advantage of its capabilities with a growing global ecosystem of ISVs, OSVs, virtualization providers, database and enterprise application vendors, data analytics vendors, open source solutions providers, Cloud Service Providers, hardware OEMs, and standards bodies, such as the Storage Network Industry Association (SNIA), ACPI, UEFI, and DMTF.

Intel® Optane™ Persistent Memory in the Data Center: Delivering Real Value Today

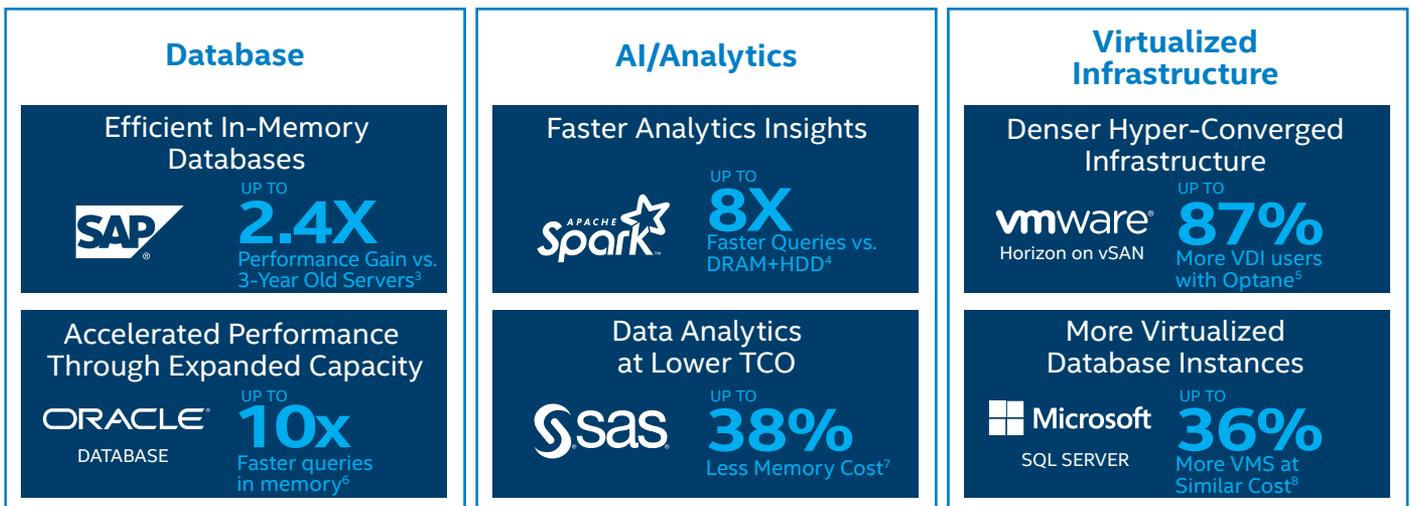


Figure 2. Intel Optane PMem boosts performance across a wide range of enterprise applications.

Programming Model

The software interface for using Intel Optane persistent memory was designed in collaboration with dozens of companies to create a unified programming model for the technology. The Storage Network Industry Association (SNIA) formed a technical workgroup, which has published a specification of the model. This software interface is independent of any specific persistent memory technology and can be used with Intel Optane PMem 200 series or any other persistent memory technology.

The model exposes three main capabilities:

- The management path allows system administrators to configure persistent memory products and check their health.
- The storage path supports the traditional storage APIs where existing applications and file systems need no change; they simply see the persistent memory as very fast storage.
- The memory-mapped path exposes persistent memory through a persistent memory-aware file system so that applications have direct load/store access to the persistent memory. This direct access does not use the page cache like traditional file systems and has been named DAX by the operating system vendors.

The Persistent Memory Development Kit (PMDK – <http://pmem.io>) provides libraries meant to make PMem programming easier. Software developers only pull in the features they need, keeping their programs lean and fast on PMem. These libraries are fully validated and performance-tuned by Intel. They are open source and product-neutral, working well on a variety of PMem products. The PMDK contains a collection of open source libraries, which build on the SNIA programming model. The PMDK is fully documented and includes code samples, tutorials, and blogs. Language support for the libraries exists in C and C++, with support for Java, Python, and other languages in progress.

Turn Data from a Burden to an Asset

Intel Optane PMem 200 series is the next-generation of a groundbreaking technology innovation. Deployed with 3rd Gen Intel Xeon Scalable processors, this technology can transform critical data workloads—from cloud and databases to in-memory analytics and content delivery networks.

Intel Optane Persistent Memory 200 Series Data Sheet

PRODUCT FAMILY	Intel® Optane™ Persistent Memory 200 Series					
FORM FACTOR	Persistent Memory Module (PMM)					
PMem SKU*	128 GiB		256 GiB		512 GiB	
USER CAPACITY	126.4 GiB		252.4 GiB		502.5 GiB	
MOQ	4	50	4	50	4	50
MM#	999HGR	999HGZ	999HH0	999HH1	999HH2	999HH3
PRODUCT CODE	NMB1XXD128GPSU4	NMB1XXD128GPSUF	NMB1XXD256GPSU4	NMB1XXD256GPSUF	NMB1XXD512GPSU4	NMB1XXD512GPSUF
MODEL STRING	NMA1XXD128GPS		NMA1XXD256GPS		NMA1XXD512GPS	
TECHNOLOGY	Intel® Optane™ Technology					
LIMITED WARRANTY	5 years					
AFR	≤ 0.44					
ENDURANCE 100% WRITES 15W 256B	292 PBW		363 PBW		300 PBW	
ENDURANCE 100% WRITES 15W 64B	91 PBW		91 PBW		75 PBW	
BANDWIDTH 100% READ 15W 256B	6.8 GB/s		6.8 GB/s		5.3 GB/s	
BANDWIDTH 100% WRITES 15W 256B	1.85 GB/s		2.3 GB/s		1.89 GB/s	
BANDWIDTH 100% READ 15W 64B	1.7 GB/s		1.75 GB/s		1.4 GB/s	
BANDWIDTH 100% WRITES 15W 64B	0.45 GB/s		0.58 GB/s		0.47 GB/s	
DDR FREQUENCY	2666, 2400, 2133, 1866 MT/s					
MAX TDP	15W		18W			
TEMPERATURE (T _{JMAX})	≤ 84°C (85°C shutdown, 83°C default) media temperature					
TEMPERATURE (T _{AMBIENT})	54°C @ 2.4m/s for 10W					
TEMPERATURE (T _{AMBIENT})	49°C @ 2.4m/s for 12W					
TEMPERATURE (T _{AMBIENT})	44°C @ 2.7m/s for 15W					
TEMPERATURE (T _{AMBIENT})	N/A		40°C @ 3.7m/s for 18W			

* GiB = 2³⁰; GB = 10⁹

Learn more at [intel.com/optanepersistentmemory](https://www.intel.com/optanepersistentmemory)



1. Baseline: 1-node, 1x Intel® Xeon® 8280L 28C @ 2.7GHz processor on Neon City with Single PMem module config (6x32GB DRAM; 1x{128GB,256GB,512GB} Intel Optane PMem 100 Series module at 15W) ucode Rev: 04002F00 running Fedora 29 kernel 5.1.18-200.fc29.x86_64, and MLC ver 3.8 with App-Direct. Source: 2020ww18_CPX_BPS_DI. Tested by Intel, on 27 Apr 2020. New configuration: 1-node, 1x Intel® Xeon® pre-production CPX6 28C @ 2.9GHz processor on Cooper City with Single PMem module config (6x32GB DRAM; 1x{128GB,256GB,512GB} Intel Optane PMem 200 Series module at 15W), ucode pre-production running Fedora 29 kernel 5.1.18-200.fc29.x86_64, and MLC ver 3.8 with App-Direct. Source: 2020ww18_CPX_BPS_BG. Tested by Intel, on 31 Mar 2020.

See configuration disclosure for details. No product or component 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 <http://www.intel.com/benchmarks>.

2. Source: IDC 2020 MaturityScope Digital Transformation

3. SAP HANA

2.4x better runtime performance: Performance results are based on testing by Intel® IT as of March 12, 2019. Baseline: three-node (1-master + 2-slave) SAP HANA® 2 scale-out configuration. Per Node: 4 x Intel® Xeon® processor E7-8880 v3 (2.3 GHz, 150 W, 18 cores), CPU sockets: 4; microcode: 0x400001c; RAM capacity: 64 x 32 GB DIMM, RAM model: DDR4 2133 Mbps; storage: GPFS, approximately 21.8 TB of formatted local storage per node, SAN storage for backup space only; network: redundant 10 gigabit Ethernet (GbE) network for storage and access, redundant 10G network for node-to-node; OS: SUSE 12 SP2*, SAP HANA: 2.00.035, GPFS: 4.2.3.10. Average time of 50 individual test queries executed 30–50 times each, for a total of approximately 25,000 steps: 2.81 seconds. New configuration, one master node SAP HANA 2 scale-up configuration: CPU: 4 x 2nd Generation Intel® Xeon® Platinum 8260 processor (2.2 GHz, 165 W, 24 cores), CPU sockets: 4; microcode: 0x400001c, RAM capacity: 24 x 64 GB DIMM, RAM model: DDR4 2133 Mbps; Intel® Optane™ DC persistent memory: 24 x 126 GB PMM; storage: XFS*, 21 TB; network: redundant 10 GbE network; OS: SUSE 15, SAP HANA: 2.00.035, Intel BKC: WW06. Average time of 50 individual test queries executed 30–50 times each, for a total of approximately 25,000 steps: 1.13 seconds.

4. Spark

Tested by Intel on February 24th 2019. Common testing details: 2x 2nd Gen Intel Xeon Platinum 8280M processor, 8xHDD ST1000NX0313, BIOS: SE5C620.86B. 0D.01.0134.100420181737, OS: Fedora release 29, kernel: 4.20.6-200.fc29.x86_64, 1-replica uncompressed & plain encoded data on Hadoop, Spark: 1 * Driver (5GB) + 2 * Executor (62 cores, 74GB), spark.sql.oap.rowgroup.size=1MB, Oracle JDK 1.8.0_161, 3TB data scale, 9 I/O intensive queries, 9 threads. Memory config of baseline: 24x32GB DDR4. Memory config of system with Intel Optane Persistent memory: 8x128GB PMem in App Direct Mode + 12x16GB DDR4.

5. VMware Horizon on vSAN VDI - Source: <https://www.principledtechnologies.com/VMware/VMware-HCI-Intel-Optane-VDI-0420.pdf>

6. OracleDB - 10X performance claim from 2019 Oracle Open World session: Delivering Enterprise Value Through Trailblazing Innovations <https://www.oracle.com/openworld/on-demand.html?bcid=6089826187001>

7. SAS® Viya® In-memory Analytics:

SAS® Viya 3.4 VDMML application. Workload: 3 concurrent logistic regression tasks each running on 400GB datasets. Testing by: Intel and SAS completed on February 15, 2019. Baseline hardware for comparison: 2S Intel® Xeon® Platinum 8280 processor, 2.7GHz, 28 cores, turbo and HT on, BIOS SE5C620.86B.0D.01.0286.011120190816, 1536GB total memory, 24 slots / 64GB / 2666 MT/s / DDR4 LRDIMM, 1x 800GB, Intel SSD DC S3710 OS Drive + 1x 1.5TB Intel Optane SSD DC P4800X NVMe Drive for CAS_DISK_CACHE + 1x 1.5TB Intel SSD DC P4610 NVMe Drive for application data, CentOS Linux® 7.6 kernel 4.19.8. New hardware tested: 2S Intel® Xeon® Platinum 8280 processor, 2.7GHz, 28 cores, turbo and HT on, BIOS SE5C620.86B.0D.01.0286.011120190816, 1536GB Intel Optane DCPMM configured in Memory Mode(8:1), 12 slots / 128GB / 2666 MT/s, 192GB DRAM, 12 slots / 16GB / 2666 MT/s DDR4 LRDIMM, 1x 800GB, Intel SSD DC S3710 OS Drive + 1x 1.5TB Intel Optane SSD DC P4800X NVMe Drive for CAS_DISK_CACHE + 1x 1.5TB Intel SSD DC P4610 NVMe Drive for application data, CentOS Linux® 7.6 kernel 4.19.8.)

8. Virtualized SQL

Performance results are based on testing as of Feb. 1, 2019 and may not reflect all publicly available security updates. Baseline configuration (DRAM): 2x 2nd Gen Intel® Xeon® Platinum 8276 @ 28 cores/socket. Memory: 768 GB (24x32 GB DDR4@2666 MHz). Network: Intel® X520 SR2 (10 Gbps). Storage: 8x Samsung® PM963M.2 960 GB, 4x Intel® SSDs S3600 (1.92 TB). BIOS: WW02'19. OS/VM: Windows Server 2019. WL Version: OLTP Cloud Benchmark (internal private customer confidential workload). Dataset/instance or workload size: 1.1 TB. Security mitigations: variants 1,2,3 enabled. Performance of 22 SQL VM instances.

Performance results are based on testing as of dates shown in configuration and may not reflect all publicly available security updates. No product or component 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 <http://www.intel.com/benchmarks>.

Intel® Optane™ persistent memory pricing & DRAM pricing as of June 8, 2020. Pricing referenced in TCO calculations is provided for guidance and planning purposes only and does not constitute a final offer. Pricing guidance is subject to change and may revise up or down based on market dynamics. Please contact your OEM/distributor for actual pricing.

Intel technologies may require enabled hardware, software, or service activation.