WORKLOAD BRIEF

Intel® Optane™ DC Persistent Memory
In-Memory Enterprise Database

Break the Cost and Capacity Barrier with Intel® Optane™ DC Persistent Memory

Redis Enterprise, a multi-model in-memory database, is optimized to take advantage of novel memory configurations based on Intel® Optane™ DC persistent memory. Data center operators can now equip servers with unprecedented system memory capacities at lower cost than dynamic random-access memory (DRAM)-only configurations. Developers have a new tier available for data placement that provides significantly faster performance than traditional storage.

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"Redis Enterprise in combination with Intel® Optane™ DC persistent memory allows developers to simplify their database deployment and application development by keeping the entire dataset in a single multi-model database."

– Yiftach Shoolman,
Co-founder and CTO, Redis Labs

Businesses of all types and sizes are looking for ways to use massive data stores to their greatest advantage. In most cases, generating value requires increasingly high levels of performance, both to handle data volumes that may be in the multi-petabyte range and to deliver timely insights and results based on that data. Conventional databases were simply not built to meet these requirements.

In-memory databases have gained popularity for exactly that reason; by holding the entire dataset in active system memory, they avoid the latency associated with reading from disk. The corresponding speed and responsiveness advantages of in-memory databases have come at a price, however. The high DRAM capacity requirements to run large-scale in-memory databases can be cost-prohibitive, often limiting their use in analytic, operational, and hybrid workloads. Because of the expense, many companies have had to compromise between performance, scalability, and budgetary requirements.

Intel Optane DC persistent memory is a breakthrough technology that packages Intel® Optane™ media in a DIMM form factor enabling module sizes of up to 512 GB, several times larger than today's DDR4 memory can currently support. This innovation makes it affordable to configure servers with larger memory capacities than was previously feasible, so that systems can hold larger data sets closer to the processor. With latency comparable to DRAM and significantly lower than other storage options, Intel Optane DC persistent memory enables businesses to extract more value from massive data sets.

Redis Labs has long-standing expertise in enabling mission-critical applications to deliver compelling user experiences. The company has worked closely with Intel to optimize the Redis Enterprise database for Intel Optane DC persistent memory, enabling sub-millisecond latency at lower cost than DRAM. Those lower costs make larger memory capacities practical, often allowing for hardware consolidation; the resulting lower server count helps reduce total cost of ownership.

Redis Enterprise

In-Memory NoSQL Database

Customer Pain Points:

- High cost of DRAM can be prohibitive for large in-memory databases
- Customers respond by splitting databases, adding complexity

Why Intel® Optane™ DC persistent memory:

- Full dataset can be deployed in a single in-memory database
- Sub-millisecond response with reduced cost

Value Proposition:

- Achieve performance SLAs with fewer servers
- Accommodate large-capacity deployments with fewer servers
- Enable real-time analytics on memory-bound workloads

A Revolutionary New Memory Tier

Intel Optane DC persistent memory enables a unique new memory tier that is byte-addressable (similar to DRAM) while also being persistent (like storage). Mapping the memory directly into applications' address space enables direct data access for reads and writes, with far lower latency than is possible with conventional storage. Providing similar performance to DRAM but at lower cost, this technology enables larger memory capacities than ever before, with 128 GB, 256 GB, and 512 GB modules available. The larger capacity allows software architects to regard memory as the main data tier, eliminating I/O bottlenecks associated with conventional combinations of discrete storage and memory.

Developer Edge with Persistent Memory

Intel® Optane™ DC persistent memory revolutionizes the performance equation with big, affordable, persistent storage on the memory bus. Use it to achieve lower latency, higher resilience, and more performance for your applications.

Learn more at software.intel.com/pmem

Two distinct operating modes are available to customers of Intel Optane DC persistent memory: Memory Mode and App Direct Mode. Memory Mode appears to the operating system and applications as volatile system memory, delivering expanded memory capacities while helping reduce system costs compared to DRAM. App Direct Mode, on the other hand, makes two levels of memory available to applications—one volatile and one persistent—giving applications the ability to optimize where specific data is placed to maximize efficiency.

Redis Enterprise takes advantage of Memory Mode, enabling customers to extend DRAM capacity using Intel Optane DC persistent memory modules plugged into memory slots on the system board. The ongoing collaboration between Intel and Redis Labs is exploring the potential of optimizing Redis Enterprise for App Direct Mode. That optimization could add further to the efficiency benefit from Intel Optane DC persistent memory.

Real-World Transformations: Fighting Fraud and Getting Personal

Among the thousands of organizations that currently rely on the capacity and performance of Redis Enterprise to power their businesses worldwide, many will benefit from the ability to combine multiple data stores on systems equipped with Intel Optane DC persistent memory. These businesses occupy many industrial verticals, and they use the database for use cases as diverse as fighting fraud, personalizing services, making recommendations for users, and improving risk predictions made with transaction scoring. The following are some illustrative examples:

- **Fraud mitigation**. Using real-time big data analytics, the financial services industry analyzes user activity, deduces patterns, and uses that information to identify anomalous behaviors that could indicate attempted fraud. Such massive, data-driven workloads that require real-time data ingest and analytics can now be implemented without excessive concern for cost or impact to performance with the seemingly unlimited capacity from Intel Optane DC persistent memory and sub-millisecond latency from Redis Enterprise. Making these measures more effective at detecting and responding to fraud reduces the potential for financial losses and reputation damage.
- **Personalization and recommendations**. The ability for e-commerce and other digital services to tailor experiences rapidly and accurately is an undeniable competitive advantage. Users expect content and products to be personally relevant to them, with a high degree of accuracy, and without delay. The combination of Redis Enterprise and Intel Optane DC persistent memory may help drive conversions and build loyalty through day-to-day personalization and targeted campaigns, while controlling the associated investments in infrastructure.

A Database Uniquely Tailored to Intel® Optane™ DC Persistent Memory

Redis Enterprise is a multi-model in-memory database platform that is used by thousands of organizations worldwide as the basis for data-rich business processes. It scales to multi-petabyte datasets and can deliver millions of operations per second with sub-millisecond latency. It supports multiple, flexible deployment options and topologies including cloud, multi-cloud, on-premises, and hybrid.

In real-world implementations, Redis Labs found that many of its customers were splitting their datasets across multiple data services to reduce infrastructure costs, keeping only the most time-critical data in Redis Enterprise. In addition to limiting performance, this approach adds a significant layer of complexity, making the environment more challenging to manage and maintain. In particular, developers must deal with multiple database engines and/or services when deploying applications.

With the combination of the Redis Enterprise database and Intel Optane DC persistent memory, customers now have an affordable approach to unifying their datasets into a single database, eliminating the complex architecture associated with splitting them out over multiple services. This solution stack offers more memory per server and throughput that rivals Redis database running on DRAM, but with a lower cost profile.

Redis Labs has been working with Intel for some time on co-engineering activities to optimize Redis Enterprise for Intel Optane DC persistent memory. Over the timeframe leading up to its public introduction, Redis Labs tested and benchmarked Intel Optane DC persistent memory across a variety of workloads and hardware configurations.

As the engineering team worked to adapt the database engine, they benefited from the fact that all of the objects and data structures were already byte-addressable, with no special serialization and deserialization processes. This core architectural characteristic of Redis Enterprise provides an enduring advantage over databases originally designed for disk-based systems. Because those databases were not designed to be byte-addressable, they are inherently limited by serialization and deserialization overheads as well as the relatively long access times of disk-based data structures.

This history of co-engineering continues to pay benefits through the Redis Enterprise database's ability to take excellent advantage of the hardware, enabling unified databases to run with high throughput, low latency, and low infrastructure costs.

Delivering Full-Stack Benefits to the Business

Intel Optane DC persistent memory enables businesses to achieve sub-millisecond latency and fast application response, using the Redis Enterprise database across data-driven workloads and use cases. By deploying the full dataset in a single in-memory database, customers streamline their infrastructures and trim costs.

As shown in Figure 1, testing using the Memtier benchmark demonstrates the ability to maintain typical customer service level agreements (SLAs) (1M ops/sec @ 1 ms latency), with reduced hardware costs.[1]

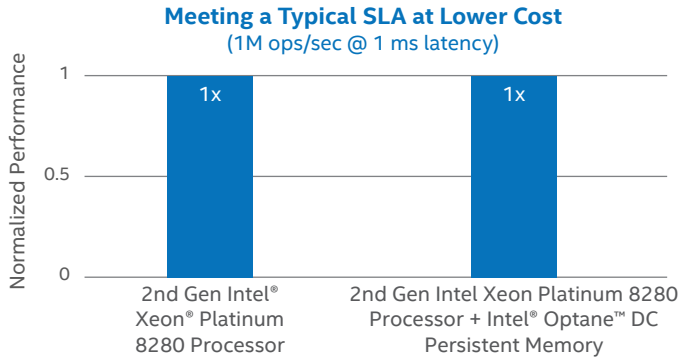

Figure 1. Maintaining a typical customer SLA with reduced server cost.[1]

Customers may also be able to accommodate larger capacity deployments with fewer servers as well as reduced hardware and operating costs, while maintaining required performance. In addition, this configuration can support less common peak performance scenarios that exceed the 1M ops/second case, while still benefiting from cost savings.[1]

In addition to the benefit of Intel Optane DC persistent memory, a further substantial hardware boost is provided by 2nd Generation Intel® Xeon® Scalable processors, which are built to enable pervasive performance and can be configured with as much as 6 TB of total system memory per CPU socket. With up to 48 cores and six memory channels per socket, and up to 48 TB of memory capacity in eight-socket systems, the potential for transformative results is clear.

Deploying Redis Enterprise using the combination of Intel Optane DC persistent memory and 2nd Gen Intel Xeon Scalable processors enables more server instances per host. That can help data center operators achieve greater density while taking advantage of fully in-memory operation, even with datasets in the multi-petabyte range. In addition, Redis Enterprise helps protect data with built-in multi-tenancy and strong isolation, complemented by powerful hardware-enhanced encryption built into the persistent memory itself.

Conclusion

Intel Optane DC persistent memory provides a flexible new memory tier that enables Redis Enterprise to make actionable insights available from data rapidly and cost-effectively. This ground breaking memory architecture allows the data engine to move, store, and process large working data sets close to the processor, extracting previously untapped value from business data.

The combination of Redis Enterprise database and Intel Optane DC persistent memory provides lightning-fast application response and low latency, as well as a simplified, single-database development and operational environment, all with reduced infrastructure costs. As a result, organizations can accelerate their application modernization journeys, innovating around new use cases and delivering engaging new customer experiences.

Take the Next Step

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www.intel.com/OptaneDCPersistentMemory

Learn how Intel Optane DC Persistent Memory gives developers a competitive edge:
software.intel.com/pmem

Learn more about the latest 2nd Gen Intel® Xeon® processors:
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[1] Testing by Intel, 2/14/2019. Memtier benchmark. Redis Enterprise 5.4. Dataset created with 6 billion key/value pairs and 100 B keys (roughly 1 TB of data set). The test workload used 50/50 puts/gets with a random distribution.

BASELINE: One node based on 2x 2nd Generation Intel® Xeon® Platinum 8280L processor (28 cores/56 threads per socket); ucode 0x4000013; Intel® Hyper-Threading Technology (Intel® HT Technology) and Intel® Turbo Boost Technology enabled; BIOS version: SE5C620.86B.0D.01.0286.011120190816; system DDR memory configuration: 1.5 TB (12x64 GB / 2666) per socket; total memory per node: 1.5 TB DDR; storage (boot): Intel® SSDSC2KB96, 1 TB; 2x Intel® Ethernet Converged Network Adapter for 40 GbE QSFP+; CentOS* Linux* 7 (Core); kernel: 4.19.8; run method: warm, data averaged over a five-minute interval; iterations and result choice: three runs (average). Raw results: 2.51 ops/sec @ 1 ms latency.

NEW: One node based on 2x 2nd Gen Intel Xeon Platinum 8280L processor (28 cores/56 threads per socket); ucode 0x4000013; Intel Hyper-Threading Technology and Intel Turbo Boost Technology enabled; BIOS version: SE5C620.86B.0D.01.0286.011120190816; BKC version: WW 4 2019 BKC; Intel® Optane™ DC Persistent Memory firmware version: 5336; system DDR memory configuration: 192 GB (6x16 GB / 2666) per socket; system Intel Optane DC Persistent Memory configuration: 1.5 TB (6x 128 GB / 2666) per socket; total memory per node: 192 GB DDR; 1.5 TB Intel Optane DC Persistent Memory; storage (boot): Intel® SSDSC2KB96, 1 TB; 2x Intel Ethernet Converged Network Adapter for 40 GbE QSFP+; CentOS Linux 7 (Core); kernel: 4.19.8; AEP mode: 2LM; run method: warm, data averaged over a five-minute interval; iterations and result choice: three runs (average). Raw results: 2.06 ops/sec @ 1 ms latency.

Performance results are based on testing as of 2/14/2019 and may not reflect all publicly available security updates. See configuration disclosure for details. No product can be absolutely secure.

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