Transactional Database Performance Boosted with Intel® Optane™ DC Persistent Memory

Tech Note by

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Summary

An efficient transactional database running large amounts of information requires heavy-duty hardware performance that can support an optimized workload output.

Dell EMC PowerEdge R740xd servers configured with Intel® Optane™ DC Persistent Memory were able to execute more transactions per minute than configurations with NAND flash NVMe drives or SATA SSDs.

The Advantage of Application Direct Mode

Intel® Optane™ DC Persistent Memory Modules (DCPMMs) have two different modes with unique advantages; **Application Direct** mode and **Memory** mode. Application Direct mode allows for OS and applications to register DCPMMs as persistent memory, while Memory mode allows for increased memory capacity over traditional DIMMs. This technical brief will focus on the advantages of using Application Direct mode.

Figure 1: The 8Rx4 PC4-2666V DCPMM has a DRAM form factor but functions as both a memory and storage technology

DCPMMs working in Application Direct mode can drive change in the following ways:

- Memory persistence is enabled; In-memory data will remain intact throughout power cycles
- Memory is read as storage; Operations can be directly performed on storage class memory instead of having to go through the time-consuming file system and storage system software layers
- Memory capacity increase; DCPMMs increase memory capacity over traditional DIMMS by roughly 50%, therefore increasing the overall capacity.

Testing was conducted to quantify the value of Microsoft SQL2019 by comparing the performances measured while running DCPMM, NVMe and SATA drive configurations.

The Testing Conditions

A Dell EMC PowerEdge R740xd server ran four storage configurations to compare performance readings:

- 12 Intel D3-S4510 SATA SSDs (capacity of 1.92 TB each)
- 2 Intel P4610 NVMe SSDs (capacity of 1.6 TB each)
- 4 Intel P4610 NVMe SSDs (capacity of 1.6 TB each)
- 12 Intel 8Rx4 PC4-2666V DCPMMs (capacity of 256 GB each)

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NVMe SSDs did not exceed four drives because the processor had reached full utilization at four and bottlenecked performance for additional drives. VMware vSphere ESXi™ software was chosen to use the DCPMMs in App Direct mode (as this recognizes the new technology and allows its persistence capabilities). vPMEM mode was chosen to give the OS and applications access to persistence. A TPC-C like workload was derived to simulate a database application that mimics a company with warehouses, parts, orders and customers, with the benchmark reporting performance in transactions per minute.

Each storage configuration ran the number of workloads required to achieve full storage saturation while fully utilizing the CPU. Tests were run and recorded three times with each test running for a total of 45 minutes, while only the last 15 minutes of each run was recorded as the system was at a steady-state. Results were then averaged and compared as transactions per minute (TPM).

The Proof of Concept

Intel® Optane™ DCPMMs showed significant performance gains compared to other storage devices, with **11.3x** the TPM of 12 SATA SSDs, **2.2x** the TPM of 2 NVMe drives and **1.7x** the TPM of 4 NVMe drives. See Figure 2 below for graphical test results:
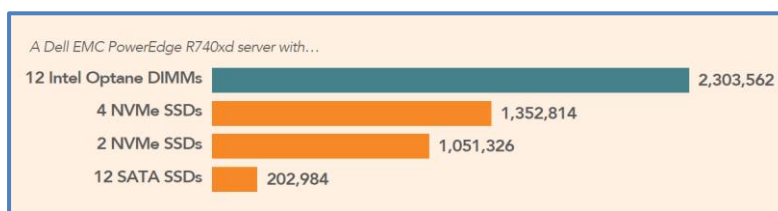

A Dell EMC PowerEdge R740xd server with…

12 Intel Optane DIMMs	2,303,562
4 NVMe SSDs	1,352,814
2 NVMe SSDs	1,051,326
12 SATA SSDs	202,984

Figure 2: Median TPMs for each storage configuration

The Future Impact of App Direct Mode

The test results validate that using DCPMMs can bring newfound value to the server market that is worth investing in. With persistence and bus lane speeds boosting performance, DCPMMs were proven capable of running 1.7x greater TPMs when compared to four NVMe SSDs and 11.2x greater TPMs when compared to twelve SATA SSDs. MSFT SQL 2019 is a fitting first entry to evangelize the value of DCPMMs, and as the next data decade unfolds, so will more opportunities to push the standards of server technology.

To read the full whitepaper publications, please access the below links:

https://principledtechnologies.com/Dell/PowerEdge-R740xd-Intel-Optane-science-1019.pdf
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