



# Reduce Memory Costs with Intel® Memory Drive Technology

**Testing conducted by Virtuozzo shows that Intel Memory Drive Technology can lower data center memory costs without increasing data center complexity.**



The ceaseless growth of data makes large amounts of memory essential in modern data centers. However, DRAM is costly and limited in capacity, making it expensive to scale up effectively in support of the infrastructure-consolidation, data, and analytics landscape. Intel partner Virtuozzo has demonstrated how to use Intel® Memory Drive Technology to shatter the memory-capacity ceiling and to configure scale-up systems that have a much lower total cost of ownership (TCO) than systems based solely on DRAM.

## **Intel Memory Drive Technology: The Benefits of Memory without Its Constraints**

Memory is the essential resource that drives many enterprise workloads. Provisioning hardware with large amounts of memory is essential in the modern data center, whether you are hosting virtual machines (VMs) and containers or running advanced analytics workloads like in-memory databases, machine learning, or high-performance computing (HPC). However, throwing more memory at workloads like these is rarely a sustainable means of scaling them in a cost-effective way.

### **The Challenge: The Upward Spiral in the Cost of Memory**

As expensive as DRAM can be, cost is not a simple or straightforward constraint to scaling up important, memory-hungry workloads. Server processors can only support so much memory; even the highest-end, latest-generation processors only support up to 1.5 TB of DRAM each—and that figure is lower for most processors, often 768 GB or less.

This hard limit to memory support does two things to drive up the cost of provisioning more memory. First, it means that getting more DRAM also means getting a large and pricey server footprint to accommodate added memory. Second, memory per unit at the high end also costs more; maximizing the 1.5 TB permitted by today's processors means stocking servers with 128-GB DIMMs, which cost more than double per gigabyte compared to 64-GB or 32-GB DIMMs. The costs to simply buying more memory can be much higher than a linear, incremental increase.

## The Solution: Intel Memory Drive Technology

Fortunately, there is another option available today: Intel® Optane™ DC Solid State Drives (SSDs) with Intel Memory Drive Technology. Intel Memory Drive Technology is revolutionary software that transparently extends your servers' memory pools, integrating the capacity of Intel Optane DC SSDs into system memory, making it look like all-DRAM to the operating system and applications. This means that you don't need to make any changes to your hardware or software stack; your apps work exactly the same with full access to the extended memory pool.

To achieve all this, Intel Memory Drive Technology uses advanced memory-management technologies. These technologies include memory-access prediction, large-scale aggressive prefetching, and asynchronous memory access. This combination of technologies optimizes performance and capacity so that the overall performance is close to that of DRAM.

Intel® Memory Drive Technology provides up to

# 8X SCALABILITY

for DRAM memory:  
up to

# 12 TB

for a single Intel® Xeon®  
Platinum processor.<sup>1</sup>

The expansion of capacity can be dramatic. For example, the extended memory capacity provided by Intel Memory Drive Technology for Intel® Xeon® Scalable processors is up to 8x higher than a server without Intel Memory Drive Technology.<sup>1</sup> For an Intel Xeon Platinum processor, that means scaling up to 12 TB per processor or 96 TB on an eight-socket server—all without having to make additional changes to your hardware or software stack.

## Reduce TCO with Intel Memory Drive Technology

Intel Memory Drive Technology changes the economics of memory for IT organizations. They can use it to extend their DRAM capacities at a fraction of the price of traditional scale-up strategies. Alternatively, Intel Memory Drive Technology can be used to displace DIMMs to reduce costs for workloads that do not necessarily need more memory.

The performance of memory extended through Intel Memory Drive Technology is close to that of DRAM, so it can be used even with demanding workloads. Concrete usage examples include:

- Increasing the number of VMs or containers hosted on a single server
- Extending in-memory processing to larger datasets for improved analytics and faster insights
- Expanding the size of datasets that HPC clusters can handle for improved research or to run simulations faster and more cost-efficiently
- Reducing memory-related capital costs for cloud providers that want to offer greater-capacity instances to their customers

The flexibility and performance of Intel Memory Drive Technology mean that it can help organizations reduce both capital expenditures (CapEx) and operating expenses (OpEx).

### Proof of Concept: The Virtuozzo\* Hyper-converged Platform

Virtuozzo is a leading software provider for hyper-converged infrastructure. The Virtuozzo\* hyper-converged platform helps companies migrate to a software-defined data center (SDDC) environment in order to consolidate workloads and infrastructure. An SDDC delivers an efficient, cost-effective way to deploy and manage both containerized and VM workloads with software-defined storage and high availability.

The Virtuozzo hyper-converged platform converges virtualization technology—system containers, a hypervisor, software-defined storage, and networking—into a single software-based platform. This convergence enables businesses to easily deploy and shift workloads to optimize density and performance within their data centers. In short, precisely the kind of workloads that can benefit from the flexibility of scaling up memory using Intel Memory Drive Technology while avoiding the costs and service disruptions inherent in other scale-up options.

### Virtuozzo Test Configuration for Intel Memory Drive Technology

Virtuozzo set out to explore the ability of Intel Memory Drive Technology to provide high-memory configurations at a low cost. To do so, engineers at the software company used a three-server test bed with the following configurations:

- 2-GB VMs on a server with 96 GB DDR4 memory
- 2-GB VMs on a server with 48 GB DDR4 memory and 48 GB memory from Intel Memory Drive Technology (96 GB total memory pool)
- 2-GB VMs on a server with 96 GB DDR4 memory and 640 GB memory from Intel Memory Drive Technology (736 GB total memory pool)

## Virtuozzo's Findings

Augmenting DRAM with Intel Memory Drive Technology proved to reduce memory costs. The per-VM memory cost using Intel Memory Drive Technology was less than the per-VM cost of using DRAM alone for the limited 2x scaling case. Moreover, Virtuozzo successfully ran all of its testing with no changes to the memory stack: all tests ran unmodified Linux\*, applications, and programming workloads. In addition, Virtuozzo ran all tests with no changes to the hardware stack. All tests ran on bare-metal servers on which Intel Memory Drive Technology was loaded from BIOS or UEFI.

## Economically Scale Data Center Memory with Intel Memory Drive Technology

Intel Memory Drive Technology provides a cost-effective way to greatly scale memory in data centers. Traditionally, scaling up memory has involved a ballooning server footprint stocked with the most expensive DDR4 DRAM DIMMs. Intel Memory Drive Technology provides a way to use more economical Intel Optane DC SSDs to augment server memory at speeds close to those offered by DRAM with no need to change the software stack.

Testing conducted by Virtuozzo on its hyper-converged platform underscores these benefits. Virtuozzo doubled the memory capacity of its server test beds for less than the per-VM cost of using DRAM alone on its regular hardware and software.

The benefits of Intel Memory Drive Technology extend far beyond VM and container hosting or infrastructure consolidation. The ability to economically scale up memory makes memory-intensive applications more cost-efficient in workloads spanning advanced analytics, in-memory databases, and cloud-service providers.

Learn more about how Intel Memory Drive Technology can benefit your workloads at [intel.com/imdt](https://intel.com/imdt).



<sup>1</sup> See [intel.com/imdt](https://intel.com/imdt).

Performance results are based on testing as of May 19, 22, and 24, 2018, and may not reflect all publicly available security updates. Configuration 1: 1 x Intel® Xeon® Gold 6145 processor at 3.7 GHz with 96 GB DDR4 RAM. Configuration 2: 1 x Intel Xeon Gold 6145 processor at 3.7 GHz with 48 GB DDR4 RAM, 48 GB from Intel® Memory Drive Technology. Configuration 3: 1 x Intel Xeon Gold 6145 processor at 3.7 GHz with 96 GB DDR4 RAM, 640 GB from Intel Memory Drive Technology. No product can be absolutely secure.

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