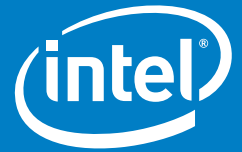


## SOLUTION BRIEF

Hybrid Cloud  
Intel® Optane™ SSDs  
Intel® 3D NAND SSDs



# Modern SSDs Set the Foundation for a Responsive Hybrid-Cloud Data Center

**New Intel® Optane™ SSDs and Intel® 3D NAND SSDs deliver enhanced levels of agility and performance to modern data centers, with a lower total cost of ownership**



## Traditional Data Centers Struggle in the Age of Digital Transformation

Is your data center keeping up in the age of digital transformation? Your toughest competitors right now are revolutionizing their data centers with new infrastructure that supports agility, innovation, and rapid development times. The legacy technologies at the heart of your business are no longer going to cut it. To compete in today's environment, your company needs to:

- Quickly roll out new apps and services to provide new customer experiences and pursue new business opportunities
- Take better advantage of the wealth of data available from customers, social media, and internal sources for actionable, data-driven insights
- Increase utilization of resources with speed, efficiency, and agility, in order to reduce costs and increase productivity

Most IT managers recognize that the most effective way to accomplish these goals is by modernizing the data center infrastructure to enable hybrid clouds. Hybrid clouds offer the value and flexibility that forward-thinking businesses need to accommodate diverse enterprise workloads. Hybrid clouds also help balance demands for rapid scale and agility with the need for control and protection of core, critical assets and intellectual property (IP). That's why hybrid clouds are fast becoming the de facto compute model as businesses transform to improve time-to-market, drive innovation, and pursue new revenue opportunities in a hyper-connected world of devices, services, and data.

## Is Legacy Storage the Bottleneck in Your Data Center?

For enterprise businesses, modernizing legacy infrastructure has become an urgent must-do, not only for enabling hybrid clouds, but also for keeping up with the performance and security demands of a digital business and for improving total cost of ownership (TCO). Compute is a good target for modernization efforts, but upgrading compute alone doesn't go far enough in optimizing the data center for increased efficiency and productivity. Specifically, upgrading compute alone doesn't address how data is moved into and out of processors. Companies that upgrade only their servers can quickly discover a new bottleneck in their overall cloud and data center performance: storage media.

Older, legacy storage technologies, like hard-disk drives (HDDs) or even Serial ATA (SATA)-based solid-state drives (SSDs), can't support the consolidation and performance required for modern applications and constantly changing business needs. Part of the problem stems from the SATA interface, which becomes a bottleneck, throttling the higher speeds that SSDs are capable of providing.

In addition to performance issues, IT staffs struggle to manage and service the older, less robust drives, which do not have modern telemetry and support features. By spending inordinate time and resources on drive servicing and management, IT organizations are diverting limited funds away from new initiatives.

In contrast, modern Intel® SSDs are fundamentally changing the game for the enterprise data center by leading the industry in migrating from older SATA HDDs and SSDs to newer Peripheral Component Interconnect Express\* (PCIe\*) drives, built with Non-Volatile Memory Express (NVMe\*) controllers. NVMe controllers provide an optimized command set that makes full use of the parallel input/output (I/O) capabilities of PCIe 3.0 to accelerate performance by a factor of eight compared to a SATA SSD.<sup>1</sup> New Intel® Optane™ SSDs with persistent memory and Intel® 3D NAND SSDs both use and extend NVMe benefits with performance, management, and other features designed specifically to support the needs of the modern hybrid cloud-based data center.

### New Intel® Data Center SSDs Are the Key to Modernization

Intel® Optane™ SSDs and Intel 3D NAND SSDs can help drive your data center modernization and hybrid-cloud initiatives. Because the new drives are efficient, high-performing, robust, and security-enabled, they support greater consolidation, agility, and expanded capabilities in the data center. In addition, Intel SSDs are built on standards-based technologies, which provide flexibility to implement the virtualization and hyper-converged cloud models of your choice across multiple vendors or open-source solutions.

### Intel® Optane™ SSDs

The Intel® Optane™ SSD DC P4800X Series is the first product to combine the attributes of memory and storage media. Intel® Optane™ SSDs accelerate applications for faster storage and improve performance for I/O- and latency-sensitive workloads. Because of their unique design, Intel® Optane™ SSDs provide performance close to that of volatile RAM, but with persistence and a cost structure closer to non-volatile NAND flash drives.

When combined with DRAM on servers powered by Intel® Xeon® processors, Intel® Optane™ SSDs use Intel® Memory Drive Technology to emulate a single volatile memory pool, with no changes needed to the operating system or applications.

Intel® Optane™ SSDs are ideal for performance-sensitive workloads that require consistent, predictable, and low latency with high performance, such as machine learning or complex analytics. With Intel® Optane™ SSDs, there is no need for the system to erase data before writing and addressing each cell. That helps reduce latency and bring performance close to the performance of DRAM, but with a cost structure closer to NAND SSDs.

Because of the price and performance of Intel® Optane™ SSDs, you can adopt them as DRAM replacements for high-performance use cases that previously were out of reach or limited due to costs. For example, you might reduce 1 TB of costly DRAM to 128 GB, and then use Intel® Optane™ SSDs as a more affordable way to cover the difference.<sup>2</sup> Intel® Optane™ SSDs can also be used as a caching tier to more quickly access “hot” data, whereas massive volumes of warm or cold data can be kept in a storage tier made up of PCIe Intel SSDs.

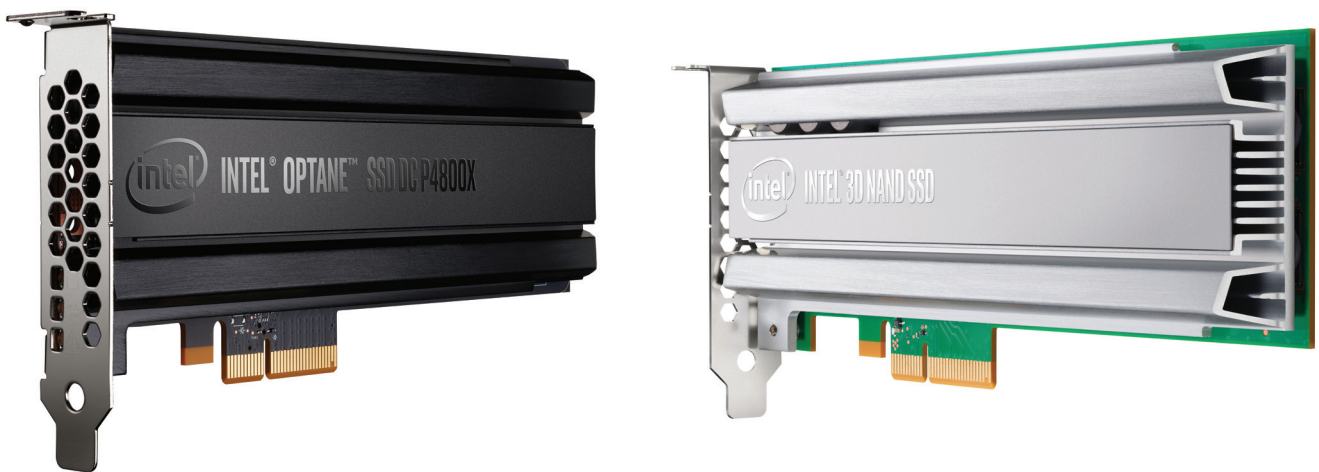


Figure 1. Revolutionary new drive technologies from Intel are driving data center modernization through performance, consolidation, and agility, with a lower TCO compared to traditional SSDs or HDDs

By using Intel® Optane™ SSDs to augment system memory in your data center, you open the door to new business possibilities and scientific discoveries. For example, you can:

- Accelerate analytics to gain new insights and broader context from larger working sets
- Work with massive data sets that were previously out of reach for machine learning, artificial intelligence (AI), or scientific-discovery initiatives
- Run more frequent analyses of large data sets for more accurate test results and improved quality assurance (QA)
- Restore complex analytics operations from a hosted cloud service to a hybrid cloud, consisting of a mix of on-premises, private cloud, and third-party public cloud services with orchestration between the platforms

## Intel SSDs Built on 3D NAND Technology

The Intel SSD DC P4500 and P4600 Series, built on 3D NAND technology, deliver up to 10.4 times the read performance of a SATA SSD at an exceptional cost-per-capacity value.<sup>3</sup> You can use fewer drives, connecting to fewer ports, with each drive consuming less power than with older-generation SSDs—all at a cost per GB comparable to that of HDDs.

In addition, the robust design and advanced capabilities of the Intel SSD DC P4500 and P4600 Series drives help preserve data integrity and minimize disruption to your data center. For example, both series of drives use the Power Loss Imminent (PLI) feature to provide protection from unplanned power loss through a propriety combination of power-management chips, capacitors, firmware algorithms, and a built-in self-test. Intel SSDs with NVMe also provide advanced telemetry to manage thermals, monitor endurance, and track drives' health statuses. And, by making use of the NVMe Management Interface (NVMe-MI) specification, Intel SSDs with NVMe can even provide out-of-band management across a wide range of drive states.

This combination of affordability, durability, and management capabilities helps protect data and reduce time and effort for your IT staff, so they can more easily manage your hybrid-cloud resources at scale, with greater simplicity and agility.

## Improve Speed and Efficiency and Lower Your TCO

Speed, efficiency, and agility are compelling reasons to upgrade. But any CIO or data center manager knows that they need to weigh benefits against TCO before pulling the trigger on a major purchase. Intel® Optane™ SSDs and Intel 3D NAND SSDs can provide a lower TCO compared to older storage media technologies because they increase CPU utilization rates, which lets you perform more work without increasing the number of servers in your data center. The drives are also far more efficient than previous-generation SSDs and HDDs, which helps reduce power and cooling costs. And they offer a robust design with built-in management capabilities (such as NVMe-MI, PLI, and advanced telemetry) that can shrink IT-support requirements.

## Intel SSDs and Intel® Xeon® Processors: Engineered Together

Intel recently announced the Intel Xeon Scalable processor, which is a new foundation for secure, agile, hybrid-cloud data centers. These processors are architected to drive storage modernization with exceptional performance and hardware-enhanced security. Designed for trusted data-service delivery, the processors are fueled by significant leaps in I/O, memory, storage, and network technologies.

When combined with advanced Intel® Optane™ SSDs and Intel 3D NAND SSDs, these processors can help you pursue innovative business initiatives by providing dramatic gains in:

- Efficiency and performance:
  - Increased I/O from additional PCIe lanes (an increase from 40 to 48 compared to the previous-generation Intel Xeon processor family) and faster data movement over each PCIe lane
  - Additional cores, with each core providing support for the higher throughput offered by Intel® Optane™ SSDs
- Management and serviceability:
  - Remote, out-of-band management with Intel® Volume Management Device (Intel® VMD) on the processor and NVMe-MI on Intel SSDs
  - Improved efficiency for IT technicians with LED indicators on SSDs and enhanced hot-plug support
- Security and reliability:
  - End-to-end data protection/integrity and support for encryption of data at rest
  - Support for online firmware updates for Intel SSDs
  - Intel Xeon processors provide a root of trust and attestation to verify trusted environments for pooled servers



## A Modern Data Center for the Digital Age

Modern infrastructure gives you the performance and capabilities you need to create a flexible and manageable hybrid-cloud environment. The next evolutionary step for the data center is to fully disaggregate and pool the underlying hardware resources into a software-defined infrastructure (SDI). With SDI, compute, storage, and networking resources can each be assigned to support workloads as needed, with agility and scalability.

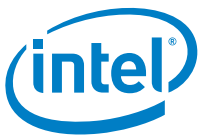
The latest generation of Intel® processors, PCIe SSDs, and networking components are engineered to support the demands of SDI architectures. By modernizing your data center infrastructure, you can expand your data center and hybrid-cloud capabilities today, while exploring your transition to an orchestrated SDI solution tomorrow. In addition, standardizing on an Intel foundation gives you access to a broad ecosystem of solutions from industry-leading OEMs and ISVs who have optimized their offerings for Intel® architecture. And because Intel supports open initiatives, you'll never be locked into a single-vendor solution.

## Start Your Modernization Journey Today

Intel has a rich portfolio of technologies to accelerate your digital transformation with a cloud-ready data center. For example, Intel® Select Solutions offer workload-optimized configurations, including modern Intel SSDs, that are verified for Intel Xeon Scalable processor-based platforms and are designed to help accelerate your infrastructure transformation. Get started on the path to greater efficiency and capabilities today by upgrading your infrastructure with Intel® Optane™ SSDs and Intel 3D NAND SSDs supported by powerful servers built on Intel Xeon Scalable processors.

### Intel Innovation Helps Transform the Modern Data Center

Intel innovation is driving the modernization and hybrid-cloud transformation of the traditional enterprise data center. Migrating to the newest generation of high-performing and energy-efficient Intel® technology-based hardware tunes your data center for highly optimized performance across a broad set of enterprise workloads while helping to lower costs and improve resource utilization. Over time, evolving to an SDI across all the critical domains of the data center (compute, storage, and network) will deliver critical automation, orchestration, and telemetry capabilities to help your business unlock the full capabilities of hybrid-cloud computing. With modern, industry-standard Intel servers and technologies that run on SDI, you can seamlessly manage an environment that supports the development and delivery of cloud-native applications and mission-critical workloads on secure private clouds, while also integrating with public clouds, many of which already run on Intel® architecture.



<sup>1</sup> PCWorld. "Everything you need to know about NVMe, the insanely fast SSDs of the future." April 2015. [pcworld.com/article/2899351/everything-you-need-to-know-about-nvme.html](http://pcworld.com/article/2899351/everything-you-need-to-know-about-nvme.html).

<sup>2</sup> Intel® Optane™ SSDs with Intel® Memory Drive Technology configuration: two Intel® Xeon® processors E5-2699 v4 (2.20 GHz), Intel® Server Board S2600WT, 128 GB DDR4 RAM plus four Intel® Optane™ SSDs (SSDPED1K375GA), and CentOS 7.3.1611\*. All-DRAM configuration: two Intel Xeon processors E5-2699 v4 (2.20 GHz), Intel Server Board S2600WT, 768 GB DDR4 RAM, CentOS 7.3.1611. Test: GEMM, segment size 18,689, factor 22, threads 42.

<sup>3</sup> Testing performed by Intel. Test and system configuration: Intel® Server Board S2600WTTR, Intel® Xeon® processor E5-2699 v3 (2.30 GHz), Intel BIOS: Internal Release, 32 GB DDR3 DRAM, Linux® CentOS® 7.0 kernel 4.8 operating system, and Intel® SSD DC P4500 Series.

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