WHITE PAPER

Transforming Business with Data

Enterprise infrastructure is pushing the boundaries of data in scope, size, and speed. The right infrastructure tools can help you make better business decisions by getting more value from data.

Writing about the data explosion is the IT equivalent of "it was a dark and stormy night." At this point, it's an old narrative that misstates the challenge and actually understates the problem. Yes, there's more data, but there are also more types of data, which further complicates how to store, activate, and monetize this modern-day resource that promises to transform companies and industries.

Advanced analytics capabilities, like artificial intelligence (AI) and machine learning, make the machine-generated unstructured and semi-structured data coming from the Internet of Things (IoT) accessible and, thus, valuable. But many companies are still not realizing the full potential of even their conventional, structured data. Less than half of companies' structured data is being actively used by decision-makers, and less than one percent of companies' unstructured data is being analyzed or used at all.[1] This data needs to be activated through better storage technologies so that companies can realize the full value of their data.

One way in which Intel helps activate data is by innovatively disrupting data centers' data tiers. Traditionally, IT organizations have faced a stark tradeoff with their storage: faster storage was much more expensive than slower storage. It only made economic sense to place the most-important, most-accessed data in fast storage. But if storage can be made faster—particularly less expensive storage—without a proportionate rise in price, more data can be analyzed and acted upon. Seizing these unprecedented opportunities offered by data requires innovative technologies like 3D NAND, Intel® Optane™ technology, and NVM Express* (NVMe*).

Reimagining Data Center Storage: Intel® Optane™ Technology, 3D NAND, and NVM Express* (NVMe*)

Storage innovation requires both faster storage media and faster storage interconnects. Data needs to be efficiently written and read, and it needs to get to processors quickly. Innovations from Intel to both media and interconnects transform the options that enterprises can bring to bear on their data-storage challenges, particularly in data tiering.

Solid State Drives (SSDs) and Intel® Optane™ Technology

Solid-state storage is one of the fastest-growing segments in storage media. This swift growth is due to the low latency of SSDs compared to hard-disk drives (HDDs). SSDs grow more efficient and dense by moving into the third dimension. Technologies like 3D NAND have increased data density by fitting more layers of data storage inside NAND chips.

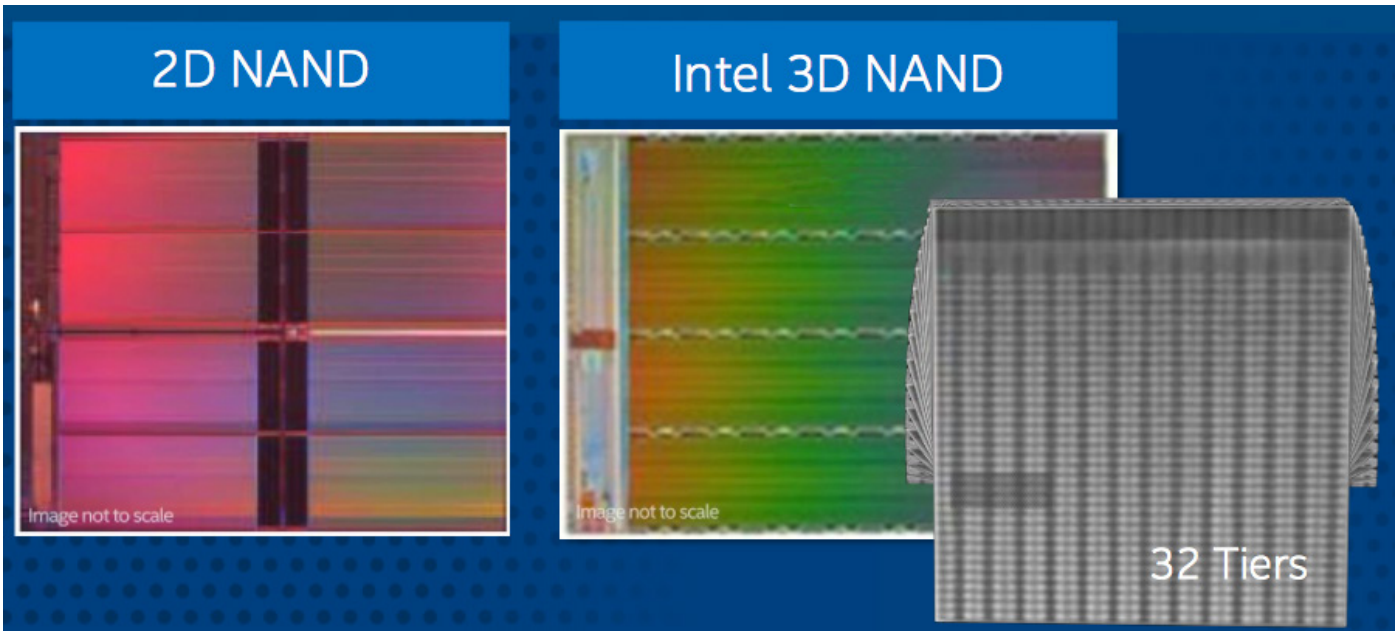

Figure 1. Comparison of a conventional, 2D NAND chip versus an Intel® 3D NAND chip with detail of 32 vertical tiers (inset)

In addition, they helped bring about the first large storage and memory technology innovation in more than 40 years: Intel® Optane™ technology. Based on Intel® 3D XPoint™ technology, Intel® Optane™ technology relies on changes in the resistance of material rather than transistors to switch individual bits between 0 and 1. This is a radical departure from all other storage and memory technologies that have come before it, and it provides unprecedented benefits.

One such benefit is low latency. Intel® Optane™ technology can provide up to 63 times lower latency than NAND-based storage.[2] It is byte-addressable (as opposed to conventional SSDs, which are only block-addressable), so it can be used in storage or memory-like capacities. It also has the ability to write in place; this ability eliminates the need to erase data before writing to its location, which slows all NAND-based technology. This necessity to reclaim unused storage space before writing to it, in combination with block-only addressability, introduces variability and latency delay to NAND-based storage. Because Intel® Optane™ technology is completely different from NAND-based storage, it does not wear out in the way that SSDs do, and thus it has longer write endurance. Intel® Optane™ technology also does not suffer from internal write amplification, the phenomenon by which the actual amount of data physically written to an SSD is greater than the logical amount of data that needs to be written to the disk. The absence of write amplification with Intel® Optane™ technology enables it to be more efficient than NAND-based storage.

Intel® Optane™ technology is the basis for two data-holding products that can directly benefit enterprise data storage and tiering: Intel® Optane™ DC SSDs and Intel® Optane™ DC Persistent Memory. Intel® Optane™ DC SSDs provide high-performance, low-latency storage. As datasets grow in size, this efficiency is vital because more data can be placed into the "warm" data tier more cost-efficiently than is possible with conventional SSDs or all-flash arrays (AFAs). This can boost the performance of applications in general and analytics in particular.

Beyond raw performance, Intel® Optane™ DC technology can reshape how enterprises tier data in other ways as well. Intel® Optane™ DC Persistent Memory runs at memory-like speeds, but it is persistent and costs less than DRAM. Intel® Optane™ DC Persistent Memory is available in a form factor called persistent memory modules (PMMs), which are similar to DIMMs, but offer greater density than is available with conventional, volatile memory. Using Intel® Optane™ DC Persistent Memory can thus reduce the overall cost of memory (and memory-like components) for in-memory databases. Its persistency also helps reduce downtime for in-memory databases because it takes less time to restart due to not needing to reload data into memory.

Interconnects: NVMe and NVMe over Fabrics* (NVMe-oF*)

Interfaces for solid-state storage are also changing and helping to retrieve data faster. Instead of interfacing SSDs to a system's Serial ATA (SATA) storage interface, NVMe coupled with PCI Express* (PCIe*) provides high-speed, low-latency, and low-power access to the underlying storage media, such as SSDs. This dramatically changes the performance model of SSD-based arrays by eliminating hardware and software latency.

NVMe over Fabrics (NVMe-oF) extends the benefits of NVMe outside of the server or storage array. It changes how the industry understands storage interconnects. NVMe-oF replaces traditional Small Computer System Interface (SCSI)-based storage interfaces with a more efficient and lower-latency protocol designed for remote SSDs over a network. NVMe-oF implementations are available for InfiniBand* interconnects, Fibre Channel* physical interconnects, high-speed Ethernet, and a range of more proprietary approaches.

Intel: Making a Precedent of the Unprecedented

One of many challenges facing storage-technology decision-makers and architects today is not just that data needs are changing, but that they rapidly continue to change in new ways. Like extreme pressure and heat transforming coal into diamonds, the amount and variety of data today create a phase-change of opportunity (and expectations) for businesses' data. These unprecedented opportunities require unprecedented technologies to seize.

Intel is familiar with both the challenges and the opportunities because of its unique placement within the technology industry. Intel is the only company that:

- Manufactures the core set of hardware
- Drives standards for the hardware
- Produces development tools to expose the features of the hardware
- Works closely with hardware vendors to implement these hardware features
- Collaborates with operating system, middleware, and app vendors to use these hardware features

Not only has Intel transformed its IT internally to meet the ongoing challenges of data and realize new opportunities, it is in constant conversations with enterprise customers on these same topics. This intimate familiarity with the modern needs of enterprises with respect to data helps drive Intel's innovation in storage technologies—innovations that open the way to new opportunities with data.

Realizing the new possibilities presented by data has two parts. The first part is innovation. More data of different types requires new technologies to handle efficiently. Intel® Optane™ technology is the first truly new kind of storage on the market since the 1970s. Solid-state data technologies like 3D NAND, Intel® Optane™ DC SSDs, and Intel® Optane™ DC Persistent Memory can help organizations fundamentally reshape how they embrace data by re-architecting storage options. To better understand how these Intel® storage technologies can help meet evolving needs for storage, read "Data, Data Everywhere—Storage on the Brink?" at intel.com/content/www/us/en/storage/building-an-enterprise-data-strategy.html.

The second part to realizing the opportunities presented by data is formulating a data strategy. Data is a strategic resource, not a source of overhead to be used and then locked on a disk or tape archive. A data strategy can help an enterprise understand and map its data and computational resources to its long-range plans. It can also help an enterprise architect how to store and protect that strategic data. For more information on formulating a data strategy for an organization, read "Defining a Data Strategy" at intel.com/content/www/us/en/storage/practical-steps-data-strategy-eguide.html.

The changing face of data today is best viewed not as an explosion, but as a rising tide that can raise those boats that are prepared for it. Resources from Intel—both technological and strategic—can help an organization not just cope with data, but seize its unprecedented opportunities. To learn more about Intel® Optane™ technology and how it can help your organization, visit intel.com/optane.

[1] DalleMule, Leandro, and Davenport, Thomas H. Harvard Business Review. "What's Your Data Strategy?" May 2017. https://hbr.org/product/whats-your-data-strategy/R1703H-PDF-ENG.

[2] Source – Intel-tested: Average read latency measured at queue depth 1 during 4k random write workload. Measured using FIO 2.15. Common Configuration - Intel 2U Server System, OS CentOS 7.5, kernel 4.17.6-1.el7.x86_64, CPU 2 x Intel® Xeon® 6154 Gold @ 3.0GHz (18 cores), RAM 256GB DDR @ 2666MHz. Configuration – Intel® Optane™ SSD DC P4800X 375GB and Intel® SSD DC P4600 1.6TB. Latency – Average read latency measured at QD1 during 4K Random Write operations using fio-2.15. System BIOS: 00.01.0013; ME Firmware: 04.00.04.294; BMC Firmware: 1.43.91f76955; FRUSDR: 1.43. The benchmark results may need to be revised as additional testing is conducted. Performance results are based on testing as of July 2018 and may not reflect all publicly available security updates. See configuration disclosure for details. No product can be absolutely secure.

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