White Paper

Optimizing Performance and Efficiency in the Modern Datacenter Using Solid State Drives

Sponsored by: Solidigm

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May 2023

IDC OPINION

Enterprise datacenters must continue to evolve to support a variety of new and emerging workloads. As datacenters evolve, so does the underlying storage technology. Increasingly, quad-level cell (QLC) solid state drives (SSDs) will be used to help drive better datacenter performance and efficiency by providing higher storage capacity at a lower cost, consuming less power, and improving the overall cost-effectiveness of data storage.

IN THIS WHITE PAPER

In this paper, IDC explores some of the challenges facing datacenters as the infrastructure prepares for the digital era. It highlights insights derived from primary research conducted by IDC with enterprise datacenter customers that are using SSDs. The research identified the ways QLC SSDs can help drive better datacenter performance and efficiency. In addition, this paper discusses the product offerings provided by Solidigm.

SITUATION OVERVIEW

The widespread use of digital technologies such as computers, the internet, mobile devices, and various digital media has brought about the digital era, which has had a profound impact on society and continues to shape the way we live, work, and communicate. At the center of the digital era is the datacenter, which plays a critical role by providing the infrastructure to store, process, and manage the vast amount of digital information that organizations and consumers create and consume on a daily basis.

The infrastructure to support the datacenter has advanced significantly over the past decade with the advent of more complex artificial intelligence (AI), high-performance computing (HPC), big data, and cloud workloads. However, the demands placed on the infrastructure continue to increase in support of data growth in the digital era and efficiently provide access to that data at speed. Today's modern datacenters must continue to evolve as they face several challenges in response to the demands placed upon them including:

- **Scalability:** Datacenters need to scale their performance and capacity to meet the demands of increasing data volumes and workloads. Scaling can be a challenge, especially when it comes to managing and maintaining consistent, high levels of performance.

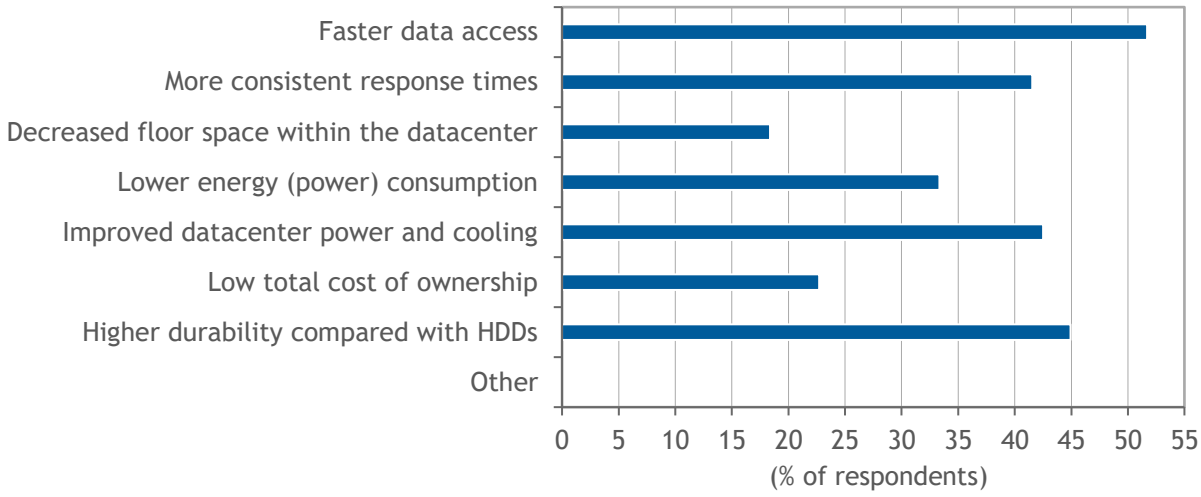
- **Energy efficiency:** Datacenters consume a significant amount of power and require efficient cooling and power management to maintain optimal performance levels.
- **Reliability and uptime:** Datacenters need to be designed and operated to ensure high levels of availability and 24 × 7 uptime, as downtime can have significant consequences.
- **Storage infrastructure complexity:** As datacenters grow, the storage infrastructure becomes more complex making it difficult to manage storage resources effectively, leading to wasted capacity and poor performance due to trade-offs between capacity, performance, and cost.
- **Cost:** Datacenters are expensive to build, operate, and maintain, and organizations need to carefully manage costs to ensure that they are spending efficiently and effectively on datacenter infrastructure.

Increasingly, datacenters are turning to solid state drives to help overcome many of the challenges. SSDs are storage devices that use NAND flash memory and deliver fast, reliable access to data. Because of these advantages, datacenter managers realize that SSDs can help address their challenges as well as provide a real tangible benefit. As a result, there has been an increased use of flash within the enterprise over the past few years. Yet just 14% of the capacity in the datacenter in 2022 was on SSDs, and while many organizations have already moved away from traditional hard disk drives (HDDs), there are still many opportunities to expand the use of SSDs across the datacenter and leverage the benefits of solid state technology. In fact, when surveying datacenter managers, many of them see some key advantages when using enterprise SSDs like faster, consistent performance to improve performance for applications and workloads; lower power consumption resulting in reduced energy costs; and a lower overall total cost of ownership (TCO) (see Figure 1).

FIGURE 1

Benefits of Solid State Drives

Q. What have been the biggest benefits of using SSD technology?



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Source: IDC, 2023

FUTURE OUTLOOK

The digital era is not slowing down the demands being placed on digital enterprise infrastructure. In fact, they will only continue to increase with the rise of modern workloads and many new applications that have an insatiable appetite for larger amounts of data. To meet this demand, businesses will need to continue to expand their storage capacity while maintaining cost-effectiveness, improving efficiency, and speeding up access to data. Datacenters will need to deal with a wide array of new and emerging workloads for which SSDs are well suited including:

- **Database workloads:** SSDs can improve the performance of databases by providing fast, random access to data.
- **Virtualization:** SSDs can be used to improve the performance and response times of virtualized environments.
- **High-performance computing:** SSDs can provide the fast I/O speeds required for high-performance computing applications.
- **Cloud computing:** SSDs can be used in cloud computing environments to provide fast storage access to cloud services.
- **Big data and analytics:** Analyzing large data sets involves reading and processing large amounts of data, which can be accelerated by using SSDs.
- **Data analytics:** SSDs can be used for analytics such as artificial intelligence or machine learning (ML), as they can provide faster access to the data.
- **Content delivery and media streaming:** SSDs can be used to store and stream multimedia content, as they can provide fast access to the data and handle large amounts of I/O operations.

As datacenters evolve, the underlying storage technology must keep pace. The storage requirements for datacenters can vary greatly depending on the size and needs of the organization that is running the datacenter. Storage I/O characteristics, data access patterns, and performance requirements can vary widely between different workloads within the datacenter.

For example, a write-intensive database workload can involve frequent write operations to the storage device as data is inserted, updated, or deleted and requires high levels of I/O activity. In contrast, workloads that are more read intensive require frequent reads from the storage device and fast access to data to deliver the data without delay. A case in point: content delivery networks (CDNs) deliver content, such as video or audio streams, to end users from multiple servers located around the world and require fast access to data and a high level of read performance to ensure a smooth user experience.

For datacenter managers, a key decision criteria for selecting storage is to understand the targeted workload and leverage the best storage media to optimize performance and efficiency of the digital infrastructure. Many datacenter managers are taking this workload approach to storage; in doing so, they have recognized they overestimated storage requirements in some situations. This has particularly been the case when considering the amount of endurance necessary for their workload.

The endurance of an SSD is a measure of how many times it can be written to before it starts to experience failures. The inherent characteristics of media and the process of writing data to the NAND flash memory cells within an SSD cause wear on those cells due to a limited number of write/erase cycles. This wear eventually leads to degradation of an SSD's ability to hold data reliably. Endurance is typically described in terms of the total amount of data that can be written to the drive, and it is usually measured in drive writes per day (DWPD) or terabytes written (TBW).

Many datacenter managers are overpaying for performance they don't need today. Overestimated storage or performance requirements leads to unnecessarily high costs and inefficiencies, according to recent IDC survey data. When evaluating storage-intensive servers, datacenter managers expect to increase their use of read-intensive SSDs by over 20% in the next 12 months at the expense of more write-intensive SSDs.

As datacenter managers seek to better align storage requirements to the media, the growing use of more read-intensive SSDs is opening the door for increasing the use of QLC NAND flash within enterprise SSDs. It is important that datacenter managers understand the performance benefits and trade-offs of using QLC NAND, especially since modern workloads and drive behaviors are now better understood. There is a common misperception that QLC has insufficient performance and endurance for certain workloads; this is often not true, particularly in today's increasingly read-intensive environment. In fact, the most advanced QLC SSDs on the market today already have read performance equivalent to triple-level cell (TLC) SSDs and ample lifetime endurance for a broad swath of datacenter workloads now and in the future.

Understanding QLC SSDs

QLC (4 bits per cell) SSDs are a type of SSD that uses NAND flash memory technology to store data. Compared with other types of SSDs such as single-level cell (SLC), multilevel cell (MLC), and triple-level cell, QLC SSDs have a higher storage density, allowing for more data to be stored in a smaller physical space. This density enables QLC SSDs to offer more cost-effective storage when measured in terms of dollar per gigabyte, helping businesses deal with data growth and control cost. QLC SSDs are typically more energy efficient than traditional HDDs, which can help reduce the overall energy consumption of datacenters. QLC SSDs provide faster data access than traditional HDDs, which can help improve the performance of applications and reduce latency to deliver the responsiveness necessary for the digital era.

However, QLC SSDs also come with some trade-offs that datacenter managers need to consider, such as slower write performance compared with other types of SSDs and lower endurance (i.e., fewer program/erase [P/E] cycles before they start to degrade), and they can have additional design challenges without sophisticated digital signal processing (DSP) and advanced error correction codes (ECCs).

Today's enterprise QLC SSDs have come a long way with newer generations of drives incorporating technologies like over-provisioning and wear leveling to help improve their endurance and reliability. These SSDs are well suited for certain mainstream and most read-intensive workloads that involve more reading than writing and where the workload doesn't require high write performance or sustained write speeds.

How QLC SSD Can Help Drive Better Datacenter Efficiency

Datacenters are increasingly leveraging SSDs for their preferred storage media. Yet according to a recent IDC survey, almost 45% of respondents suggested that SSD costs are still too high. QLC SSDs are more cost effective compared with other types of SSDs. This cost advantage is due to the use of more bits per cell, which reduces the cost per gigabyte. This makes QLC SSDs a more affordable option for datacenters that need to store large amounts of data. In fact, today, QLC SSDs satisfy the top areas that datacenter managers are looking to drive improvements, including increasing storage capacity and density, speeding up data access, and improving TCO (see Figure 2).

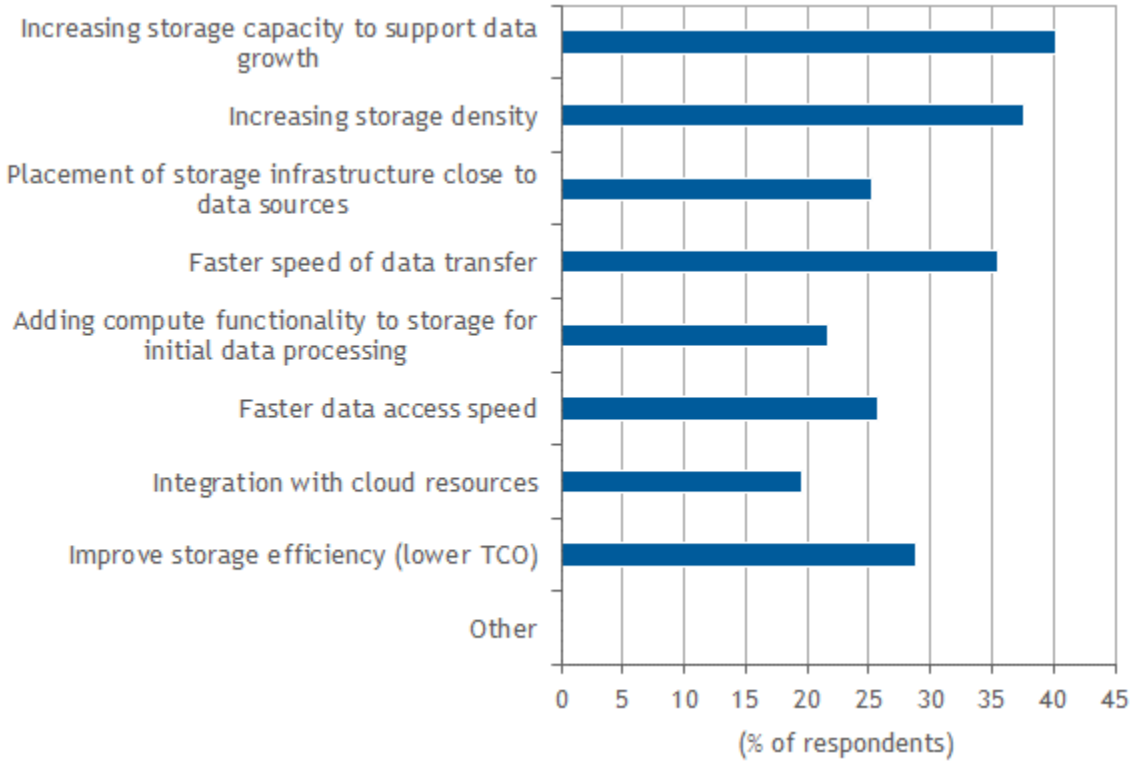
The question for many datacenter managers is why pay a premium for performance when QLC SSDs are an ideal fit to deliver more storage capacity and faster access to data while lowering cost per gigabyte.

For example, database applications that are more read intensive often utilize TLC NAND for low-latency performance. This is a large market where QLC NAND could meet the endurance and performance requirements of the workload at significantly lower cost.

FIGURE 2

Top Areas of Improvement for Datacenters

Q. What are your top areas of improvement you would like to see for your storage-intensive servers?



n = 194

Note: Respondents indicated that their organization uses storage-intensive servers for compute and storage hardware systems.

Source: IDC, 2023

CONSIDERING SOLIDIGM

Solidigm is a new storage company that comprises the storage industry's best inventors, leaders, and problem solvers from Intel and SK hynix. Solidigm was formed in late 2021 with the merger of Intel's former NAND SSD business and SK hynix's NAND business. Solidigm brings to market an unmatched technology portfolio with the backing of the SK Group to drive innovation cadence on par with industry leaders and the ability to scale manufacturing faster than the industry. Solidigm is headquartered in San Jose, California, with nearly 2,000 employees in 20 locations across the globe.

Solidigm has been a leader in the development of leading-edge QLC NAND and has been shipping QLC SSDs in volume since 2018 for enterprise applications. The company's product teams have been focused on delivering QLC NAND designed to offer the best value proposition for performance, reliability, and cost for the workloads of today and into the future.

CONCLUSION

Evolving workloads and requirements line up well with the benefits of QLC NAND flash-based SSDs. Today's workloads are increasingly read intensive and value massive amounts of data. The need for cost-effective storage that meets these performance and endurance requirements is growing along with these changing needs. QLC can help fill these requirements while lowering costs. Since some datacenter managers overpay for storage and performance, there is a growing portion of the market that could benefit from adopting QLC. These datacenter managers must first overcome the common misperception that QLC performance and endurance are insufficient for certain workloads. Solidigm is at the forefront of this effort, and in the era of big data and artificial intelligence, cost-effective storage solutions have never been more critical to enable future business success.

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