KIOXIA

Technical Brief

Economics of High-Capacity SSDs in the Data Center

Realizing Storage, Power, Energy and Space Efficiencies

Each AI workload stage requires specific storage capabilities and performance. While multiple factors dictate AI performance, the growing data pool remains one of the biggest aspects shaping today's data centers. For example, AI data ingestion and training require big datasets - and the bigger the datasets, the better that the AI generated responses will be. As large language models (LLMs) evolve, increasingly more data will be available to train from, resulting in massively larger datasets. This dataset growth is a major concern for data center architects building AI systems, as well as IT professionals managing them, leading all to wonder – will there be enough storage to hold all this data? Data lakes, real-time analytics, machine learning, object storage, media streaming, high-performance computing and medical imaging represent applications that manage massive datasets.

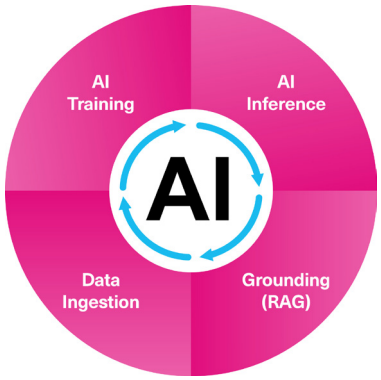
KIOXIA LC9 Series 245.76 TB E3.L SSDs[2] earned a 'Best of Show' award at FMS 2025

The ability to increase storage density is an objective when managing these data-intensive applications, enabling more capacity in a smaller space and being mindful of the system's power budget. High-capacity SSDs built with quad-level cell (QLC) flash memory are a great solution to meet these objectives and dramatically improve storage density and power consumption within the same footprint. Prior to the AI explosion, SSD capacity sweet spots in application servers and all-flash arrays were 3.84 terabytes[1] (TB) and 7.68 TB. Over the past two years, SSD capacities have grown tremendously from 15.36 TB to a whopping 245.76 TB, driven heavily by AI.

The need for significantly more flash storage also means that many more SSDs will be required. Without flash storage, lower performance is expected especially if HDDs are used or if only small portions of a dataset are used at a time. Lower performance can lead to an inability to run some applications and can strand or underutilize system resources. Adding more SSDs obviously increases infrastructure costs. In this data-intensive AI era, are there solutions that can scale storage cost-effectively?

Dell Technologies® launched a new high-density system that supports up to 9.8 petabytes[1] (PB) of flash storage in a single 2U Dell™ PowerEdge™ R7725xd server. It features up to 40 KIOXIA LC9 Series 245.76 TB E3.L SSDs. This ultra-high-density system enables a new class of storage-optimized platforms built to meet the demands of massive data ingestion streams, large-scale data lakes and data-intensive enterprise workloads in a fraction of the footprint, providing economic benefits.

This tech brief showcases key economics associated with the capacity, power consumption, energy cost and space advantages of this new high-density server/storage system when compared with similar system configurations that utilize much smaller, but more common 15.36 TB and 30.72 TB SSD capacities. The comparisons show that the high-density Dell PowerEdge R7725xd server loaded with 245.76 TB E3.L SSDs deliver server rack and economic efficiencies.



AI Workloads
Source: KIOXIA Corporation[3]

AI Workload Challenges

AI workloads have different power usage requirements when compared with the cyclical workloads (and predictable performance) that data centers are used to. Conversely, AI workloads are typically continuous and need maximum storage capacity. For example, when training an LLM, hundreds of megawatt-hours could be used over weeks or even months, and this continuous training generates significant heat that requires thermal solutions which also drive-up energy costs. Thousands of GPUs could be used, amplifying power consumption even further. Today's AI workloads are stressing data center infrastructures like never before.

To get a better handle on some of these AI workloads in a server/storage configuration, there are some key metrics that can be evaluated and provide guidance in data center/application planning. These metrics include:

- ***Terabytes per Watt (TB/W)***
  Used to measure how many terabytes of data a storage system can hold or actively process for every 1 watt of power consumed. A higher number indicates a more efficient use of power.
- ***Watts per Terabyte (W/TB)***
  Used to measure how much power is required for 1 TB of data. A lower number indicates better efficiency, meaning less power is required to store the same amount of data.
- ***Total Server Power Required with SSDs***
  Used to measure the total server power consumption with SSDs deployed.
- ***Estimated Energy Cost for Configured System***
  Used to measure the estimated energy cost to run a fully configured system in cost per kilowatt-hour (kWh).
- ***Estimated Server Rack/Floor Space Required***
  Used to measure the estimated rack or floor space required in rack units (RUs) and number of server racks.

For this tech brief, these metrics were used to compare the Dell™ PowerEdge™ R7725xd server / 40 KIOXIA LC9 Series 245.76 TB E3.L SSD system to other server/storage configurations using 30.72 TB and 15.36 TB SSD capacities.

Comparisons

To better understand the storage, power, energy and space efficiencies of the Dell PowerEdge R7725xd server / 40 KIOXIA LC9 Series 245.76 TB E3.L SSD system, two comparisons were conducted. The comparisons utilize published specifications covering the servers and SSDs and are theoretical versus actual lab testing in a data center. Using published specifications, the comparisons do not take into account other factors that could impact energy consumption in a data center such as servers operating 24/7 to ensure access to stored data, or equipment cooling to prevent overheating and maintain server performance, or security systems to protect data from physical and digital intrusion, or the size of the data center itself where energy consumption is higher per square foot, or other, infrastructure requirements. Optimizing electricity consumption through advanced data center management techniques requires consideration of varied factors to reduce energy costs and improve operational efficiency.

Comparison 1: Maximum Storage Capacity per Server
This single server comparison compares one Dell PowerEdge R7725xd server with 40 KIOXIA LC9 Series 245.76 TB E3.L SSDs to 30.72 TB and 15.36 TB configurations as follows:

- *Dell PowerEdge R7725xd server with 40 KIOXIA LC9 Series 30.72 TB E3.S SSDs*
- *Dell PowerEdge R7725xd server with 40 KIOXIA CD9P Series 15.36 TB E3.S SSDs*
- *Previous generation Dell PowerEdge 2U server with 24 KIOXIA CD8P Series 15.36 TB 2.5-inch[4] SSDs*

Storage capacity, total server power consumed, estimated energy cost and system floor space needed are compared:

Single Server/Storage Configuration	Maximum Storage Capacity	SSD Power Consumption*	Server Power Consumption w/o SSDs*	Server Power Consumption with SSDs*	Estimated Energy Cost $0.1745/kWh+	Floor Space Needed^
Dell PowerEdge R7725xd with 40 KIOXIA LC9 245.76 TB E3.L SSDs	9,830 TB (9.83 PB)	1 SSD = 30W 40 SSDs = 1,200W	447W	1,647W	$0.2874 kWh	2U
Dell PowerEdge R7725xd with 40 KIOXIA LC9 30.72 TB E3.S SSDs	1,229 TB (1.22 PB)	1 SSD = 25W 40 SSDs = 1,000W	447W	1,447W	$0.2525 kWh	2U
Dell PowerEdge R7725xd with 40 KIOXIA CD9P 15.36 TB E3.S SSDs	614 TB (0.61 PB)	1 SSD = 23W 40 SSDs = 920W	447W	1,367W	$0.2385 kWh	2U
Previous generation Dell PowerEdge 2U server with 24 KIOXIA CD8P Series 15.36 TB 2.5-inch SSDs	368 TB (0.36 PB)	1 SSD = 23W 24 SSDs = 552W	619W	1,171W	$0.2043 kWh	2U

* *Based on published specifications as of this publication date.*
\+ *Based on an average kWh rate obtained from ChooseEnergy.com as of this publication date.*
^ *Assumes 24U per rack or 12 2U servers.*

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Analysis:

The Dell™ PowerEdge™ R7725xd server / 40 KIOXIA LC9 Series 245.76 TB E3.L SSD system provides an 8x increase in storage capacity when compared to the Dell PowerEdge R7725xd 30.72 TB E3.S SSD configuration and has a 12% increase in system power consumption. The system also provides a 16x increase in storage capacity when compared to the Dell PowerEdge R7725xd 15.36 TB SSD E3.S configuration and has a 17% increase in system power consumption. As a result, IT professionals can have major increases in storage capacity at reasonable energy costs. The real benefit is showcased when the other server/storage configurations with 30.72 TB and 15.36 TB SSD capacities are scaled to support 9.8 PB storage capacities as presented next.

Comparison 2: SSD Quantity, Power Consumption, Energy Cost Metrics and Floor Space to Achieve 9.8 PB

This comparison shows the requirements of each server/storage configuration to achieve 9.8 PB of storage capacity that the Dell PowerEdge R7725xd server / 40 KIOXIA LC9 Series 245.76 TB E3.L SSD system is capable of. The configurations for comparison include:

- *Dell PowerEdge R7725xd server with 40 KIOXIA LC9 Series 30.72 TB E3.S SSDs*
- *Dell PowerEdge R7725xd server with 40 KIOXIA CD9P Series 15.36 TB E3.S SSDs*
- *Previous generation Dell PowerEdge 2U server with 24 KIOXIA CD8P Series 15.36 TB 2.5-inch SSDs plus previous generation Dell PowerEdge 2U server with 16 KIOXIA CD8P Series 15.36 TB 2.5-inch SSDs*

The comparison metrics include:

- *The number of SSDs and servers required*
- *Total power required to run*
- *Estimated energy cost (based on $0.1745 per kWh)*
- *Floor space needed*
- *TB/W (higher results are better)*
- *W/TB (lower results are better)*

Server/Storage Configuration	No. of SSDs Required	SSD Power Consumption*	Server Power Consumption w/o SSDs*	Server Power Consumption with SSDs*	Estimated Energy Cost $0.1745/kWh+	Floor Space Needed^	TB/W W/TB#
Dell PowerEdge R7725xd with 40 KIOXIA LC9 245.76 TB E3.L SSDs	40 SSDs (9.8 PB)	1 SSD = 30W 40 SSDs =1,200W	447W (x1 server)	1,647W (x1 server + SSDs)	$0.2874 kWh	2U (~8% of 1 rack)	5.96 TB/W 0.17 W/TB
Dell PowerEdge R7725xd with 40 KIOXIA LC9 30.72 TB E3.S SSDs	320 SSDs (9.8 PB)	1 SSD = 25W 320 SSDs =8,000W	3,576W (447W x8 servers)	11,576W (x8 servers + SSDs)	$2.02 kWh	16U (~67% of 1 rack)	0.84 TB/W 1.17 W/TB
Dell PowerEdge R7725xd with 40 KIOXIA CD9P 15.36 TB E3.S SSDs	640 SSDs (9.8 PB)	1 SSD = 23W 640 SSDs =14,720W	7,152W (447W x16 servers)	21,872W (x16 servers + SSDs)	$3.8166 kWh	32U (100% of 1 rack + 33% of 2nd rack)	0.44 TB/W 2.22 W/TB
Previous generation Dell PowerEdge 2U servers - with 24 KIOXIA CD8P Series 15.36 TB 2.5-inch SSDs and 16 KIOXIA CD8P Series 15.36 TB 2.5-inch SSDs	640 SSDs (9.8 PB)	1 SSD = 23W 640 SSDs =14,720W	16,713W (619W x27 servers)	31,443W (x27 servers + SSDs)	$5.486 kWh	54U (100% of racks 1 & 2 + 25% of 3rd rack)	0.31 TB/W 3.19 W/TB

** Based on published specifications as of this publication date.*
\+ Based on an average kWh rate obtained from ChooseEnergy.com as of this publication date.
^ Assumes 24U per rack or 12 2U servers.
 # For TB/W, higher results are better – for W/TB, lower results are better.

Analysis:

To achieve the same 9.8 PB storage capacity as the Dell PowerEdge R7725xd server / 40 KIOXIA LC9 Series 245.76 TB E3.L SSD system, the other three configurations show major deficiencies in all metrics compared:

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Dell™ PowerEdge™ R7725xd server with 40 KIOXIA LC9 Series 30.72 TB E3.S SSDs:

- *Requires 280 additional SSDs and 7 additional servers*
- *The additional SSDs generate 6,800 more watts - the additional servers generate 3,129 more watts - resulting in an additional 9,929W of total server power consumption with SSDs*
- *The estimated energy costs increase by $1.7326 kWh*
- *Takes up about 59% more rack space*
- *Delivers 85% lower TB/W and 85% higher W/TB*

Dell PowerEdge R7725xd server with 40 KIOXIA CD9P Series 15.36 TB E3.S SSDs:

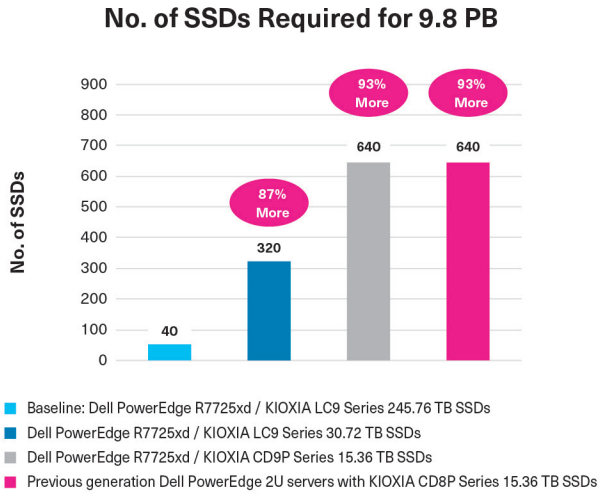
- *Requires 600 additional SSDs and 15 additional servers*
- *The additional SSDs generate 13,520 more watts - the additional servers generate 6,705 more watts - resulting in an additional 20,225W of total server power consumption with SSDs*
- *The estimated energy costs increase by $3.5292 kWh*
- *Requires 1 additional rack and about 33% of a second rack*
- *Delivers 92% lower TB/W and 92% higher W/TB*

Previous generation Dell PowerEdge 2U servers with 24 KIOXIA CD8P Series 15.36 TB 2.5-inch SSDs and 16 KIOXIA CD8P Series 15.36 TB 2.5-inch SSDs:

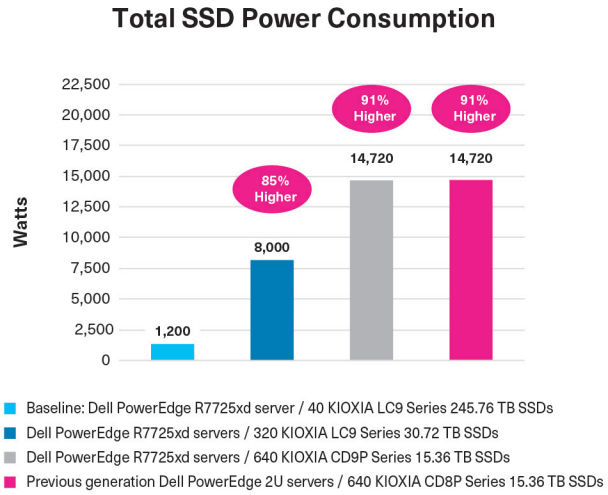
- *Requires 600 additional SSDs and 26 additional servers*
- *The additional SSDs generate 13,520 more watts - the additional servers generate 16,266 more watts - resulting in an additional 29,796W of total server power consumption with SSDs*
- *The estimated energy costs increase by $5.1986 kWh*
- *Requires 2 additional racks and about 25% of a third rack*
- *Delivers 94% lower TB/W and 94% higher W/TB*

Conclusions

The charts below show the advantages of a single Dell PowerEdge R7725xd server with 40 KIOXIA LC9 Series 245.76 TB E3.L SSDs over 30.72 TB and 15.36 TB server/storage configurations:



Lower results are better.



Assumes 30W per KIOXIA LC9 Series E3.L SSD.
Assumes 25W per KIOXIA LC9 Series E3.S SSD.
Assumes 23W per KIOXIA CD9P/CD8P Series SSD.
Lower results are better.

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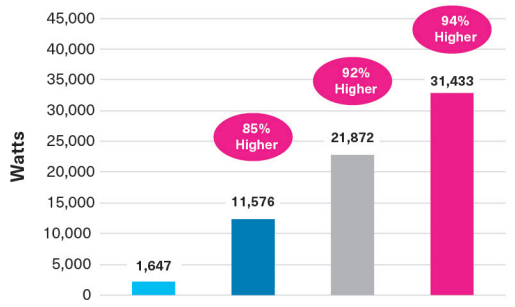
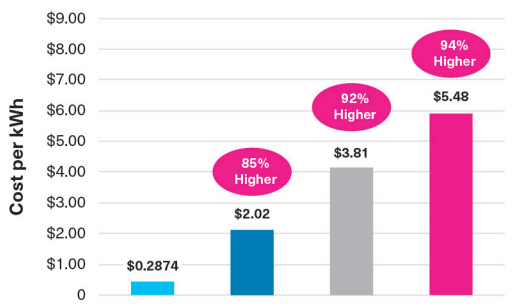
Total Server Power Consumption w/SSDs



- Baseline: 1x Dell™ PowerEdge™ R7725xd server / 40 KIOXIA LC9 Series 245.76 TB SSDs
- 8x Dell PowerEdge R7725xd servers / 320 KIOXIA LC9 Series 30.72 TB SSDs
- 16x Dell PowerEdge R7725xd servers / 640 KIOXIA CD9P Series 15.36 TB SSDs
- 27x Previous generation Dell PowerEdge 2U servers / 640 KIOXIA CD8P Series 15.36 TB SSDs

Based on published specifications as of this publication date.
Assumes 30W per KIOXIA LC9 Series E3.L SSD.
Assumes 25W per KIOXIA LC9 Series E3.S SSD.
Assumes 23W per KIOXIA CD9P/CD8P SSD.
Lower results are better.

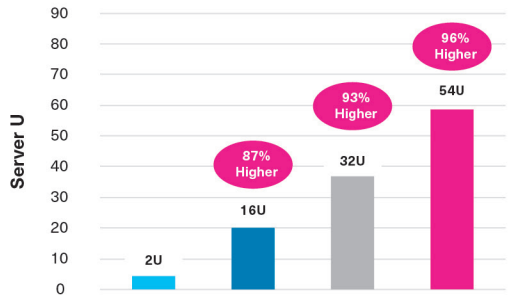
Estimated Energy Cost @ $0.1745/kWh



- Baseline: 1x Dell PowerEdge R7725xd server / 40 KIOXIA LC9 Series 245.76 TB SSDs
- 8x Dell PowerEdge R7725xd servers / 320 KIOXIA LC9 Series 30.72 TB SSDs
- 16x Dell PowerEdge R7725xd servers / 640 KIOXIA CD9P Series 15.36 TB SSDs
- 27x Previous generation Dell PowerEdge 2U servers / 640 KIOXIA CD8P Series 15.36 TB SSDs

Based on an average kWh rate obtained from ChooseEnergy.com as of this publication date.
Lower results are better.

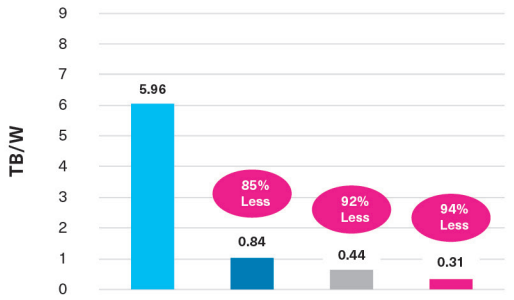
Floor Space Needed



- Baseline: 1x Dell PowerEdge R7725xd server / 40 KIOXIA LC9 Series 245.76 TB SSDs
- 8x Dell PowerEdge R7725xd servers / 320 KIOXIA LC9 Series 30.72 TB SSDs
- 16x Dell PowerEdge R7725xd servers / 640 KIOXIA CD9P Series 15.36 TB SSDs
- 27x Previous generation Dell PowerEdge 2U servers / 640 KIOXIA CD8P Series 15.36 TB SSDs

Assumes 24U per rack or 12 2U servers.
Lower results are better.

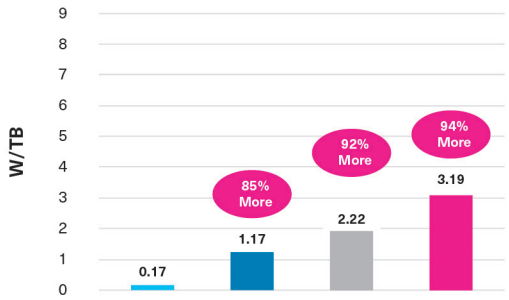
TB/W



- Baseline: 1x Dell PowerEdge R7725xd server / 40 KIOXIA LC9 Series 245.76 TB SSDs
- 8x Dell PowerEdge R7725xd servers / 320 KIOXIA LC9 Series 30.72 TB SSDs
- 16x Dell PowerEdge R7725xd servers / 640 KIOXIA CD9P Series 15.36 TB SSDs
- 27x Previous generation Dell PowerEdge 2U servers / 640 KIOXIA CD8P Series 15.36 TB SSDs

Higher results are better.

W/TB



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- 8x Dell PowerEdge R7725xd servers / 320 KIOXIA LC9 Series 30.72 TB SSDs
- 16x Dell PowerEdge R7725xd servers / 640 KIOXIA CD9P Series 15.36 TB SSDs
- 27x Previous generation Dell PowerEdge 2U servers / 640 KIOXIA CD8P Series 15.36 TB SSDs

Lower results are better.

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The economics and savings for 9.8 PB of flash storage using 245.76 TB E3.L SSDs in a Dell™ PowerEdge™ R7725xd server are very significant for all metrics reviewed in this tech brief when compared to the 30.72 TB and 15.36 TB server/storage configurations.

When compared to the 8 Dell PowerEdge R7725xd servers with 320 KIOXIA LC9 Series 30.72 TB E3.S SSDs, the 245.76 TB configuration provides 87% reduction in the number of SSDs required, floor space needed and TB/W, as well as 85% reduction in total power consumption, estimated energy cost and W/TB.

When compared to the 16 Dell PowerEdge R7725xd servers with 640 KIOXIA CD9P Series 15.36 TB E3.S SSDs, the 245.76 TB configuration provides 92% reduction in the number of SSDs required, total power consumption, estimated energy cost and W/TB. The 245.76 TB configuration also delivers 92% higher TB/W.

When compared to the 27 previous generation Dell PowerEdge 2U servers with 640 KIOXIA CD8P Series 15.36 TB 2.5-inch SSDs, the 245.76 TB configuration provides 92% reduction in the number of SSDs required and a 94% reduction in total power consumption, estimated energy cost, floor space needed and W/TB. The 245.76 TB configuration also requires 96% less floor space needed and has 94% higher TB/W.

A server/storage system with 9.8 PB of flash memory provides additional benefits:

- *Fewer PCIe® lanes, freeing them up for other server components.*
- *Much lower cooling requirements, further reducing energy consumption since only one server needs to be cooled compared to 8, 16 or 27 servers in the other configurations.*
- *Easier management of a single server versus many servers.*
- *No additional networking equipment to connect multiple servers.*
- *Fewer components mean fewer points of failure.*

By delivering extreme density, high performance and greater energy efficiency, the Dell PowerEdge R7725xd server / 40 KIOXIA LC9 Series 245.76 TB E3.L SSD system will enable organizations to modernize their infrastructures and keep pace with accelerating data growth and AI adoption.

More information:

- *KIOXIA LC9 Series SSDs available here.*
- *KIOXIA CD9P/CD8P Series SSDs available here.*
- *Dell PowerEdge R7725xd Server available here.*

REFERENCES:

KIOXIA LC9 Series 245.76 TB E3.L SSDs use 30W per drive.
KIOXIA LC9 Series 30.72 TB E3.S SSDs use 25W per drive.
KIOXIA CD9P Series 15.36 TB E3.S SSDs use 23W per drive.
KIOXIA CD8P Series 15.36 TB 2.5-inch SSDs use 23W per drive.
Dell PowerEdge R7725xd server power specifications (without drives) obtained from published product specifications
Estimated energy costs obtained from ChooseEnergy.com as of this publication date.
A typical server rack is 24U, or 12 2U servers. It is likely that networking and power regulations would use some rack slots but were factored out to remove assumptions for non-server components.

FOOTNOTES:

[1] Definition of capacity: KIOXIA Corporation defines a megabyte (MB) as 1,000,000 bytes, a gigabyte (GB) as 1,000,000,000 bytes, a terabyte (TB) as 1,000,000,000,000 bytes and a petabyte (PB) as 1,000,000,000,000,000 bytes. A computer operating system, however, reports storage capacity using powers of 2 for the definition of 1Gbit = 2^{30} bits = 1,073,741,824 bits, 1GB = 2^{30} bytes = 1,073,741,824 bytes, 1TB = 2^{40} bytes = 1,099,511,627,776 bytes and 1PB = 2^{40} bytes = 1,125,899,906,842,624 bytes and therefore shows less storage capacity. Available storage capacity (including examples of various media files) will vary based on file size, formatting, settings, software and operating system, and/or pre-installed software applications, or media content. Actual formatted capacity may vary.

[2] The product images shown are representations of the design model and not accurate product depictions.

[3] KIOXIA + AI infographic, published March 2025, V2.0.

[4] 2.5-inch indicates the form factor of the SSD and not its physical size.

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