Advanced NAND, Impressive QoS, and High Capacities for Data Center Environments

The Micron® 7450 SSD with NVMe™ is the world's most advanced 176-layer NAND data center SSD[1] — achieving 2ms and lower quality of service (QoS)[2] latency for random read and write workloads, offering high capacities for broad deployment options, and delivering extensive security features.[3]

Meeting Today's Data Center Demands

Data center operators are seeing rapidly evolving challenges and increasing demands in their business, such as: How to ensure essential applications are consistently responsive? How to securely store the ever-increasing amounts of business-critical data? How to pack more data into fewer systems while keeping it secure and easy to support?

The Micron 7450 SSD offers low and consistent latency to improve application performance[4]. Built with Micron's 176-layer NAND, the 7450 SSD achieves at or below 2ms QoS latency[4] on random read and write workloads, which enables fast and responsive data center applications. High-density form factors such as a 7.68TB E1.S can enable dozens of SSDs in a single platform (up to 246TB [32x7.68TB] in a 1U server).[5]

With an array of form factors (E1.S, U.3, and M.2) and Micron's Secure Execution Environment — a dedicated, hardware security processing engine within the SSD controller — the 7450 SSD offers the optimal combination of performance, consistent latency, and flexibility demanded by today's data center workloads.

Top Ways the 7450 SSD Transforms Storage

Improves storage performance for data center workloads with industry-leading NAND

The 7450 SSD uses industry-leading 176-layer NAND combining an independent word-line technology with Micron CMOS-under-array (CuA) architecture. This helps enable faster booting and application responsiveness.

Enables rapid, reliable, and responsive data center storage infrastructure with low QoS read latency

The 7450 SSD enables at or below 2ms latency on demanding random, mixed-IO (read and write) workloads. This helps improve the performance of latency-sensitive workloads (video-on-demand, transaction processing, multitenant hosting, real-time analytics and social media, resource planning, and other delay-sensitive applications).[6]

Offers options to support a wide variety of data center applications — reducing qualification time, costs, and complexity

The 7450 SSD offers the industry's widest[7] capacity range — from 400GB to 15.36TB, including a 7.68TB E1.S and a 15.36TB U.3. Combined with the industry's broadest variety of form factors, the 7450 meets evolving power and thermal needs as data centers transform from legacy to Enterprise and Data Center SSD Form Factor (EDSFF) storage.

The 7450 SSD is the only PCIe® Gen4 U.3 drive in the industry available in both 15mm and 7mm. It is designed for high-capacity SSD needs and offers a PCIe Gen4 M.2 22x80mm with power loss protection — specifically designed for server boot use.[7]

1. Statement is based on widely available PCIe data center SSD products, capacity points, endurance values, form factors, and 176-layer NAND at the time of this document's publication.
2. Quality of Service (QoS) is a common metric for describing latency consistency, see the SNIA dictionary https://www.snia.org/education/online-dictionary/term/qos
3. No hardware, software or system can provide absolute security under all conditions. Micron assumes no liability for lost, stolen or corrupted data arising from the use of any Micron products, including those products that incorporate any of the mentioned security features.
4. Performance is understood to mean IOPS, MB/s, or latency consistency.
5. https://www.supermicro.com/en/products/system/1U/1029/SSG-1029P-NEL32R.cfm
6. Micron internal testing shows sub-2ms 6x9 QoS latency at and below QD 32 for the Micron 7450 SSD at 3.8TB or higher, which aligns to common data center workload queue depth for a broad variety of applications. See also https://www.snia.org/sites/default/files/PM-Summit/2020/presentations/14_RWW_AI_Kim_Yang_final_PM_Summit_2020.pdf
7. M.2 is well-suited for boot use as it does not occupy a conventional storage slot.

Advanced NAND Improves Storage Performance for Many Data Center Workloads

To keep up with increasing data demands, the storage industry needs improved performance and expanded capacity. To meet these demands, Micron is pushing NAND flash technology to new heights in capacity, performance, and power efficiency with 176-layer NAND, the most advanced NAND in a data center SSD.[8]

176-Layer NAND Technology

Micron's 176-layer NAND uses replacement gate (RG) technology, which moves separate insulators to a single insulator (Figure 1). This change reduces the electric field duration, which contributes to power efficiency (an electric field is used to program data on the circuits).

With this 176-layer NAND, fewer and lower strength electrical pulses program data into the NAND. Fewer pulses mean less time is required to program data into the NAND cell, which can improve NAND write performance (Figure 2).[9]

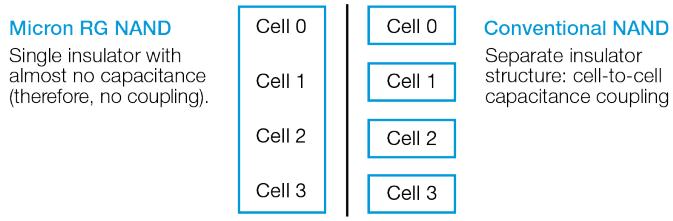

Figure 1: NAND insulator improvements

Micron also places the controlling CMOS circuitry under the NAND array (referred to as CuA, as shown in Figure 3). Placing the CMOS under the NAND array can save critical layout space. NAND that does not use CuA technology locates the CMOS control circuitry beside the NAND array, which typically consumes more space without adding additional storage capacity.

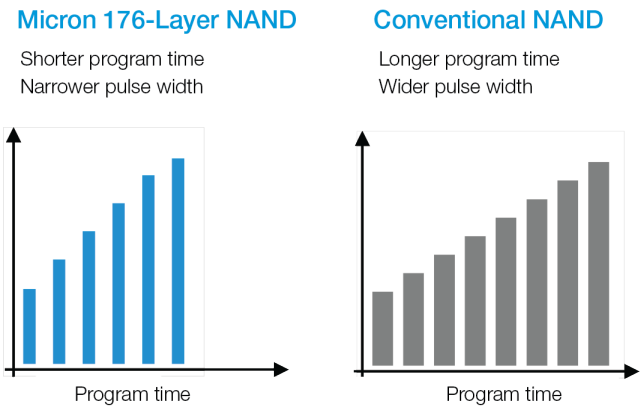

Figure 2: Improved power efficiency (through shorter NAND program times)

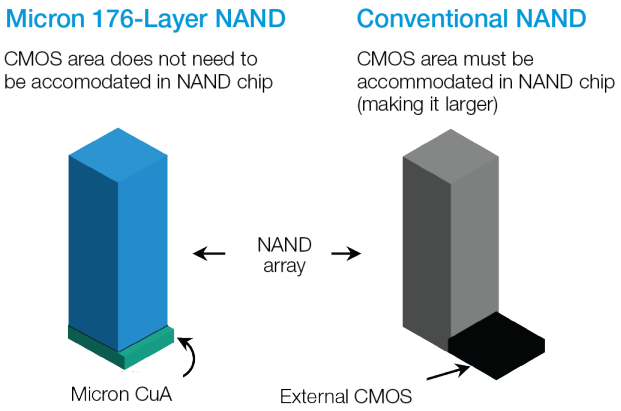

Figure 3: Micron CuA space savings compared to a conventional NAND design

8. Statement based on NAND layer count, shorter and fewer programming pulses, and use of CMOS under the array technology.
9. Comparison is based on Micron's high-volume, floating-gate 96-layer NAND: https://www.micron.com/products/nand-flash/176-layer-nand

2ms and Lower QoS Latency Enables Fast, Reliable Responsiveness in Data Center Workloads

Many data center applications require real-time responsiveness — they use, process, and respond to data that must be delivered quickly, reliably, and consistently. These applications, such as such as active SQL and NoSQL databases and voice/video applications, are delay-sensitive. Data must be delivered on time. Delivery delays or interruptions can be detrimental — voice calls can be unintelligible or video can freeze.

Quality of Service (QoS)[10] is a metric that describes application latency consistency in an SSD. QoS latency is often expressed in a number of "nines" (such as, 99.9999% or "six nines") and a threshold value (such as 2ms) for a given workload. A six-nines 2ms latency means that 99.9999% of all application IO occurs within a 2ms time.

Unlike many previous SSDs, the 7450 SSD delivers latencies at or below 2ms — and remains there — for six-nines latency in mixed, random workloads and common queue depths (QDs). This can improve performance in databases like Microsoft SQL Server, Oracle, MySQL, RocksDB (representing cloud workloads), Cassandra, and Aerospike, among others.

Figures 4 and 5 show 99.9999% ready latency vs. IOPS for a 70% read (R), 30% write (W) workload and a 90% R, 10% W workload, respectively, for a 15.36TB Micron 7450 SSD. All of the data points below the blue line are at or below the 2ms latency threshold[11].

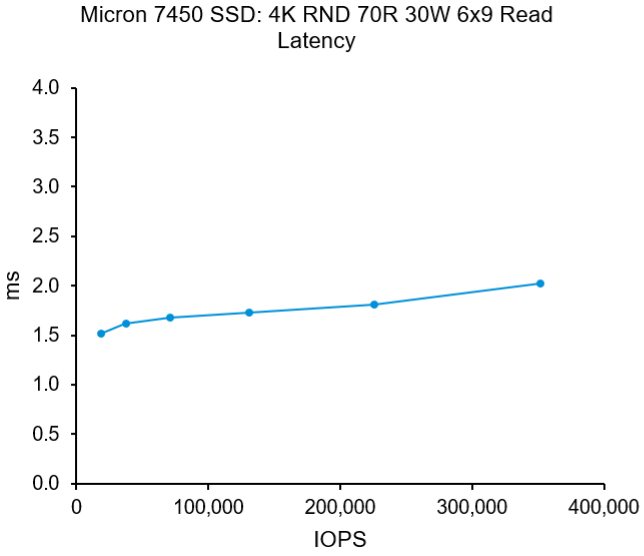

Figure 4: 70/30 mixed, random IO 6x9 OPS vs. latencies

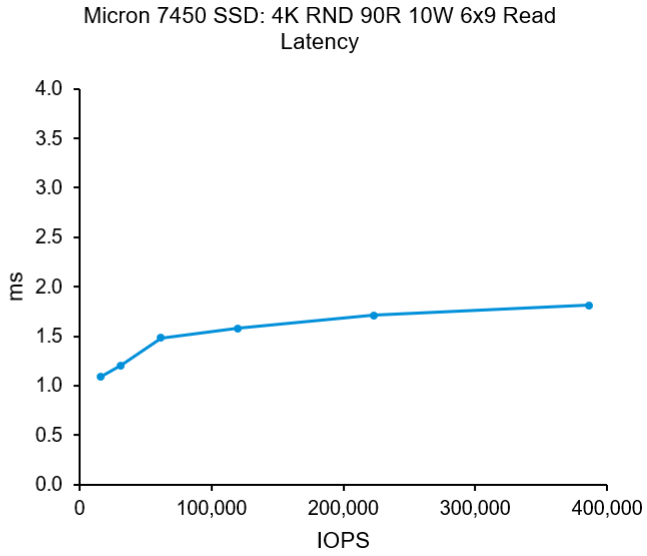

Figure 5: 90/10 mixed, random IO 6x9 OPS vs. latencies

10. From the SNIA dictionary https://www.snia.org/education/online-dictionary/term/qos
11. Based on Micron internal testing.

Options to Fit a Wide Variety of Data Centers — Reducing Qualification Time, Costs, and Complexity

The Micron 7450 SSD comes in an array of form factors, capacity sizes, and deployment options optimized for the data center.

E1.S form factor: Designed for line of business applications and hyperscale uses[12]

The E1.S form factor is designed to provide flexibility to balance performance, capacity, scale, and power.

- Capacities from 800GB to 7.68TB
- Three standard z-heights ideal for 1U platforms: 5.9mm to help maximize platform density, 25mm to help maximize performance, 15mm for balanced designs
- 4-lane PCIe with a standard EDSFF connector
- PCIe Gen4 support

U.3 form factor: Built on broad industry adoption (of the U.2 form factor)

The U.3 form factor is the latest evolution of the existing U.2 form factor standard, which has seen broad adoption in data centers.

- Capacities from 800GB to 15.36TB
- Two z-heights: 7mm or 15mm in a U.3 enclosure
- Active SNIA and PCI-SIG SFF industry standards groups for ongoing development
- Hot-plug and hot-add support makes service easy
- Fully backward-compatible with U.2 hosts[13,14]

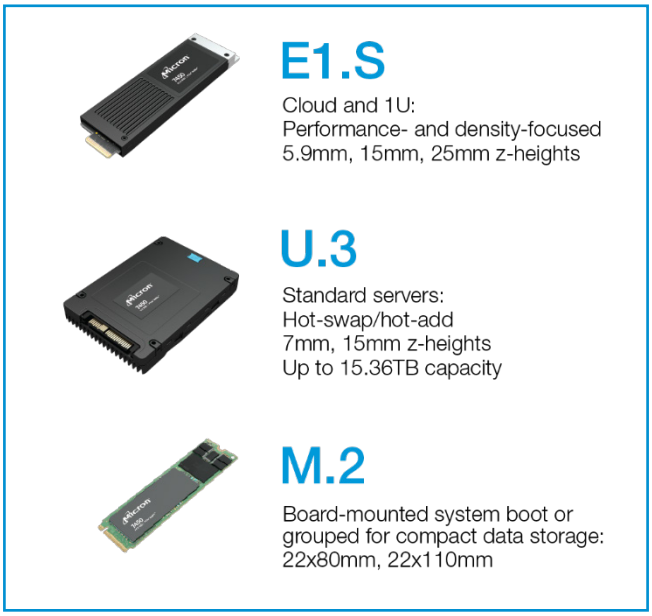

Figure 6: Micron 7450 SSD form factors and common use cases

M.2 form factor: Designed for internally mounted (non-hot swap), compact storage

M.2 form factors have been adopted in the data center as both a system boot solution and a compact data storage device (often in groups to improve density).

- Capacities from 400GB to 3.84TB
- 22x80mm and 22x110mm M.2 form factors
- PCIe Gen4 x4 interface
- Existing industry adoption
- Active standard development
- Small with low power draw

12. Statement is based on "EDSFF – A Dynamic Family of Form Factors for Data Center SSDs" https://www.snia.org/sites/default/files/SSSI/OCP EDSFF JM Hands.pdf
13. https://www.storagereview.com/news/evolving-storage-with-sff-ta-1001-u-3-universal-drive-bays
14. See https://pcisig.com/specifications for specification details.

Advanced Security Options and a Common Firmware Architecture

The Micron 7450 SSD offers advanced security options (including FIPS 140-3 Level 2, SED, Non-SED, Microsoft eDrive) to help tailor security to deployment requirements. It also leverages Micron's Secure Execution Environment (SEE) with dedicated security processing hardware with physical isolation for improved security.

State-of-the-Art Security Features

The 7450 SSD offers a robust complement of proven security features built over generations of Micron data center SSDs, helping to address emerging concerns as data and data-driven applications are virtualized, moved to the cloud, or containerized.

Micron 7450 SSD Feature	Benefit
Secure Execution Environment	Includes dedicated security processing hardware with physical isolation for security-related function isolation
Asymmetric Roots of Trust	Enables authenticated revocation of root keys (in immutable ROM)
Strong Asymmetric Key Support	Uses standard, National Institute of Standards and Technology (NIST)-approved algorithms with 208-bit/3072-bit RSA keys
FIPS 140-3 Level 2	A U.S. government security standard[15]

Table 3: Micron 7450 SSD security features

Common Firmware Architecture

The 7450 SSD shares a common firmware architecture across all form factors, capacities, and endurance ratings. This commonality helps reduce qualification time, costs, and complexity. A single firmware architecture across multiple models means that once the architecture is validated, it may not need to be validated on each and every SSD model. Common firmware architecture standardizes SSD management and status reporting, as well as firmware update mechanisms. Simply stated, the common firmware architecture can help reduce SSD qualification time (especially across multiple platforms).

Micron 7450 SSD: The World's Most Advanced 176-Layer NAND-Based Data Center SSD

The Micron 7450 SSD is the world's most advanced 176-layer NAND-based data center SSD, achieving at or below sub-2ms QoS latencies with additional drive capacities and the broad form factor options to enable a wide variety of data center workloads. It improves storage performance for most data center workloads, offers QoS latency that enables rapid, reliable, and responsive data center workloads, and features capacity up to 15.36TB with broad deployment options and enhanced security features.

15. See https://www.snia.org/education/online-dictionary/term/federal-information-processing-standardhttps://www.snia.org/education/online-dictionary/term/federal-information-processing-standard