

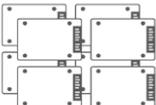
# Micron® 9300 NVMe™ SSDs Set a New Benchmark for OLTP Performance

OLTP Workloads Thrive on Fast, Consistent Results. Micron NVMe SSDs Deliver.

## Overview

In this technical brief, we compare new orders per minute (NOPM), a measure of business throughput, with average and 99.9th percentile latency using standardized online transaction processing (OLTP) performance metrics and a very large data set (too large to fit into available system memory). Our results highlight the business impact of high-performance Micron 9300 SSDs in OLTP environments versus SATA SSDs. The 9300 SSDs enable more work in a smaller space.

We tested three storage configurations: two with NVMe SSDs and one with SATA SSDs as a baseline. Each configuration uses the same base hardware (server, CPUs and DRAM):

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**2x NVMe:** 2x 3.8TB 9300 PRO SSDs in Mirrored Storage Spaces
- 
**4x NVMe:** 4x 3.8TB 9300 PRO in Mirrored Storage Spaces
- 
**8x SATA:** 8x 1.92TB enterprise SATA SSDs using RAID 10 (baseline configuration)

We found that NVMe SSDs generate 2.5 to 2.7 times higher transaction rates, bringing real value to OLTP workloads on Microsoft® SQL Server.

The NVMe configurations responded quickly and consistently, with 23% to 32% lower average latency and 88% to 89% lower 99.9th percentile latency.

Micron® 9300 Series of SSDs with NVMe™



### Increased Business Throughput

2.5X to 2.7X increased NOPM compared to an all-SATA configuration, which can translate into increased transaction rates and number of orders fulfilled.



### Faster Response

Average response time reduced up to 32% with nearly 90% lower 99.9th percentile response times.

## Increased Throughput, Fewer Drives

SSDs are a mainstay of high-performance, low-latency IT systems. High-capacity, ultra-performance NVMe SSDs like Micron's 9300 series drive those systems farther and faster, processing more data and bringing more value than two to four times as many enterprise SATA SSDs.

In OLTP systems, higher NOPM can represent more orders entered and fulfilled, bringing more value. The magnitude of the NOPM difference found between a Micron 9300 PRO-based platform and one using eight enterprise 1.92TB SATA SSDs is shown in Figure 1. Each configuration's relative transaction rate shown is at system load, just before the test reached a stop condition (see How We Tested for stop condition details).

The NVMe configurations' NOPM values are extremely high. The 2x NVMe configuration reached 1.5X more NOPM than the baseline, and the 4x NVMe configuration reached 1.7X more.

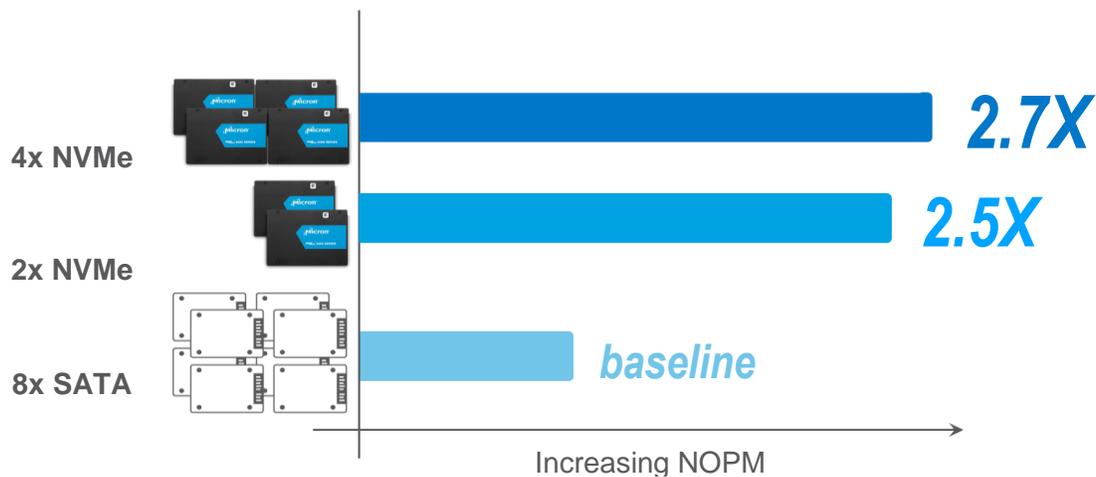


Figure 1: Relative NOPM by Storage Configuration

## Fast, Consistent Transaction Response

High transaction rates (NOPM) are required for many applications while quick, consistent database response (latency) may be more important for time-sensitive applications.

We measured and compared the mean latency and the 99.9th percentile latency (a good indicator of latency consistency) at system load just before the test reached a stop condition (see How We Tested for stop condition details) for the three storage configurations. We used the same metrics, database and test conditions.

Figures 2a and 2b show these results (lower is better in both figures).

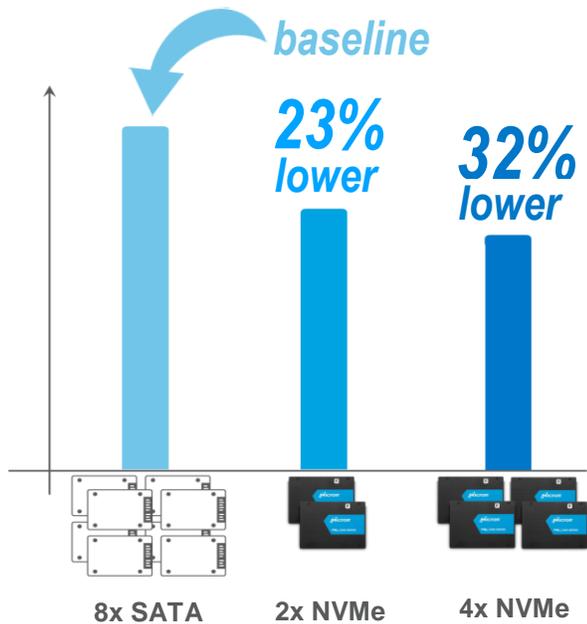


Figure 2a: Mean Transaction Time

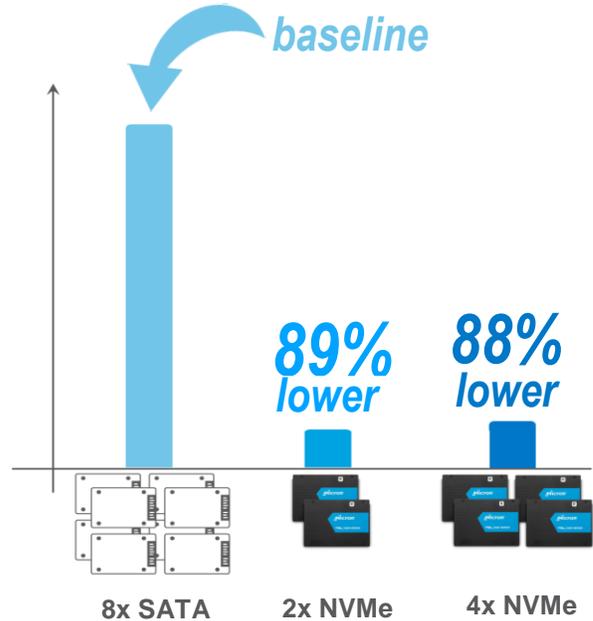


Figure 2b: 99.9% Transaction Time

Both NVMe configurations showed significantly lower mean transaction times compared to the baseline SATA SSD configuration. Figure 2a shows that the 2x NVMe SSD configuration measured 23% lower and the 4x NVMe SSD configuration measured 32% lower than baseline. Figure 2b shows that the NVMe configurations' response times were more consistent than the baseline configuration's response time (lower 99.9% transaction response time). The two comparisons indicate that both NVMe configurations respond more quickly and consistently than the baseline configuration.

## Calculating Power Efficiency (Watts/NOPM)

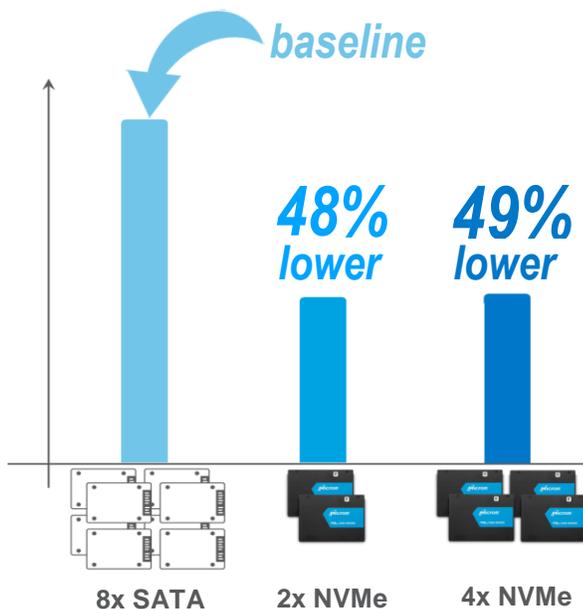


Figure 3: Relative Power Consumption per NOPM

We derive power efficiency by combining system power (in Watts) measured at reported NOPM with total system power consumption at the same NOPM. Figure 3 shows these relative values for all three configurations (lower is better).

## The Bottom Line

NVMe SSDs demonstrate tremendous benefits with Microsoft SQL Server and an OLTP workload. Supporting far higher transaction rates with lower, more consistent latency means more transactions completed faster with more consistency.

The Micron 9300 SSDs bring new capabilities to one of the most popular database management systems and one of the most challenging workloads.

In this Technical Brief, we compared OLTP performance measured in NOPM, using a data set that far exceeded platform memory capacity. Our testing examined transaction rates, mean response time and response time consistency. Both 9300 SSD configurations showed compelling results while using a fraction the number of drives compared to an enterprise SATA SSD configuration.

Mission-critical data can't wait. Access delays or inconsistency can be extremely costly. Using NVMe SSDs enables fast transaction processing and fast, consistent response times. Learn more about NVMe SSDs and their transformative effect on your business at [micron.com](https://www.micron.com).

## How We Tested

To ensure a fair assessment of each configuration’s capabilities, including the maximum expected transaction rate, we took a configuration-specific approach. We measured each configuration’s NOPM at the maximum load the platform could reasonably support (as opposed to comparing these rates and latency at an arbitrary load).

Before testing, we established stop conditions. As we tested, we increased the load until the test reached a stop condition. Then we stopped increasing the load and used the NOPM and latency values recorded when we reached the stop condition.

## Determining Maximum Load by Configuration (Stop Conditions)

This section shows the test condition(s) that established each configuration’s maximum load.

### 9300 PRO Stop Condition: Performance Plateau

Figure 4 shows benchmark performance versus transaction latency. The points circled in green represent points at which increasing the load on the 9300 PRO configurations yielded a performance increase that was not commensurate with the increased latency. The test data shown in this brief reflects this maximal loading for the two 9300 configurations.

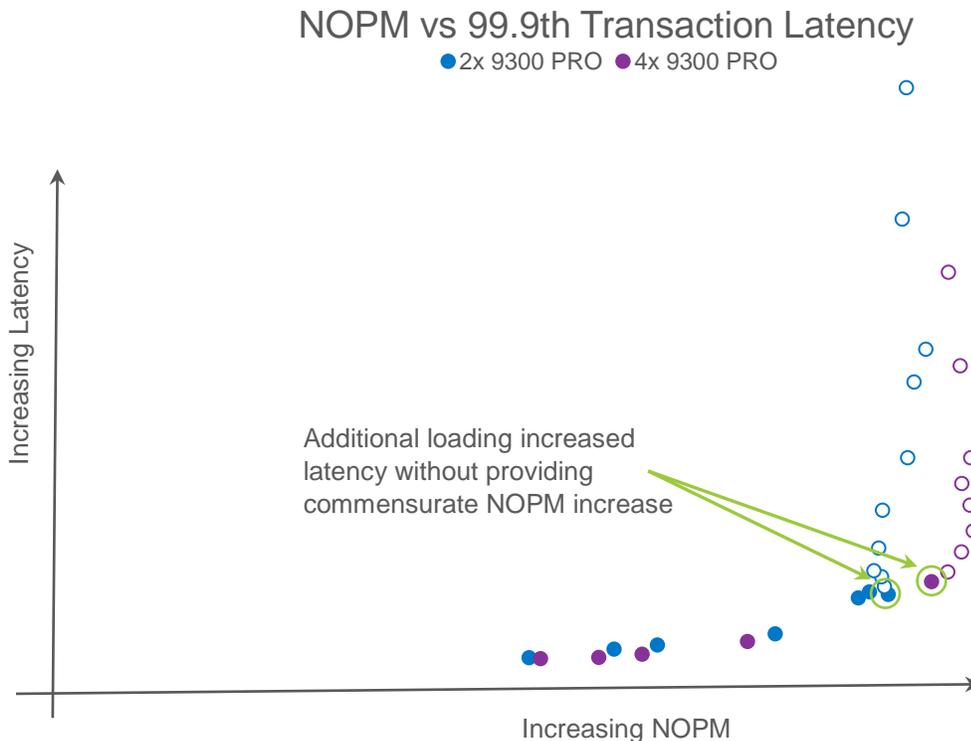
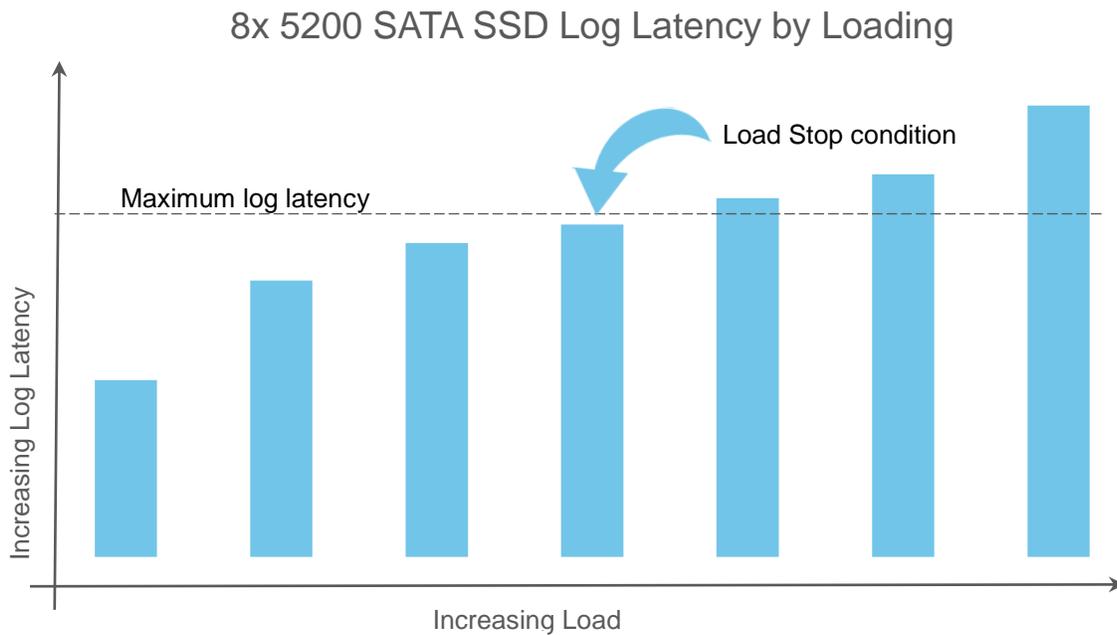


Figure 4: 9300 Stop Condition

## SATA Stop Condition: Log Latency



**Figure 5: SATA Stop Condition**

Figure 5 shows maximum loading for the SATA configuration just before the log write latency exceeds 5ms (best practice).

## Tested Server Configuration Details

Table 3 shows the hardware and software configuration details of our testing.

Component	Description
Server	2U, 2-socket (Intel-based)
CPUs	Intel® Xeon® Platinum 8168 24-core (x2)
NVMe SSDs	Micron 9300 PRO 3.8TB (x2, x4)
SATA SSDs	Enterprise SATA 1.92TB (x8)
Storage Configuration	NVMe: Mirrored Storage Spaces SATA: RAID 10
Operating System	Microsoft Windows Server® 2019 Datacenter (x64)
SQL Server	2017 Enterprise Edition (x64)

**Table 3: Hardware and Software Configuration**

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