Micron® 5100 MAX: OLTP at The Next Level

Increased OPM, Better Latency and Lower Power than Legacy Storage

Microsoft's SQL Server is one of the most widely deployed relational database management systems (RDBMS) in the world. The RDBMS platform manages high capacity, high bandwidth transaction-based applications for order entry and fulfillment, real-time data analysis and a host of other OLTP-type workloads.

State of the art e-commerce and real-time order management systems must enable access to mission-critical data: access delays can be extremely costly. These systems must enable fast transaction processing with ultra-low and consistent latency. A combination of all three drives better outcomes faster.

In this Technical Brief we use standardized OLTP performance metrics and a dataset whose size exceeds available system memory to compare orders per minute (OPM), database average response time, response time consistency and power consumption.

We use three storage configurations and the same base hardware (server, CPUs and DRAM) with each:

1. Legacy: 16x 300GB SAS 15K RPM HDDs (RAID 10; 2.4TB total capacity)
2. 5100 MAX: 4x 960GB 5100 MAX SSDs (RAID 10; 1.9TB total capacity)
3. 5100 MAX: 8x 960GB 5100 MAX SSDs (RAID 10; 3.8TB total capacity)

We found that the 5100 MAX configurations offer superior OPM, lower average latency and more consistent response time than the HDD configuration – while consuming less power per transaction.

More Orders Per Minute Than Legacy HDDs

SSDs are a mainstay of high performance, low latency IT systems. With the introduction of lower price, workload-tailored SSDs like the 5100 MAX, we now have SSDs perfectly tailored to meet the needs of high performance, latency sensitive workloads in the middle of the widespread data deluge.

5100 MAX SSD Family[1]:

*M.2 and U.2**

Compared to HDDs

Orders Per Minute (OPM)

Storage	OPM
4x 5100 MAX	3.8x more
8x 5100 MAX	10.7x more

Average Latency

Storage	Change
4x 5100 MAX	33% better
8x 5100 MAX	41% better

99.9 Percentile Latency

Storage	Change
4x 5100 MAX	60% better
8x 5100 MAX	73% better

Power Efficiency

Storage	Change
4x 5100 MAX	5x better
8x 5100 MAX	15x better

[1] 960GB 2.5" tested, other form factors and capacities are available

[2] Making the database larger than available DRAM ensures storage system IO

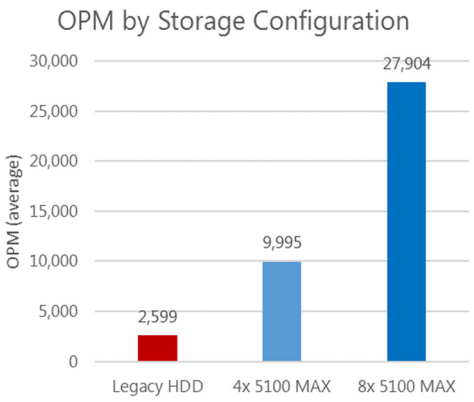

Figure 1: OPM

The 5100 MAX offers a practical, cost-optimized SSD that enables phenomenal OPM compared to the legacy stalwart: 15K RPM HDDS.

Even this 'performance' class of HDDs are painfully slow compared to the 5100 MAX – a fact that becomes very clear in Figure 1, showing OPM for all 3 configurations.

In our tests the HDD configuration reached 2,599 OPM, while the 4x 5100 measured 3.8x more that the HDDs. The 8x 5100 was even better, measuring 10.7x more than the HDDs.

Lower, More Consistent Response Times

While greater OPM is highly desirable, quick database response (latency) and how consistently it does so may be more important for applications that are very time-sensitive.

We measured the average latency and the 99.9th percentile latency (a good indicator of latency consistency) for the same three storage configurations we used for OPM measurements. We used the same metrics, database and test conditions. Figures 2a and 2b show the results. In both figures, lower is better

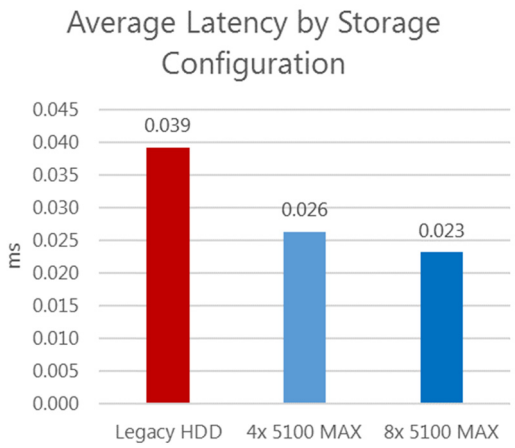

Figure 2a: Average Latency

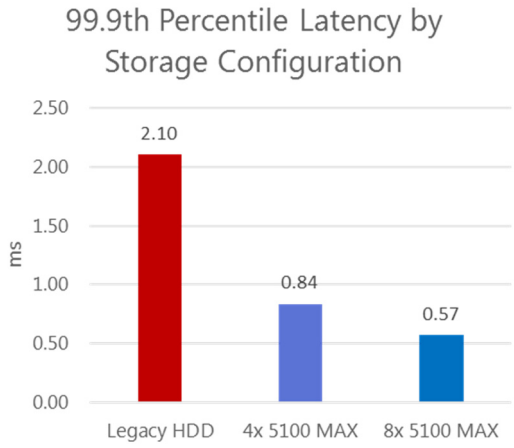

Figure 2b: 99.9th Percentile Latency

Power/Performance Efficiency

We have seen that both 5100 MAX configurations offer better OPM, better average and more consistent (99.9th percentile) latencies. These results are not surprising.

SSDs offer another, perhaps more significant benefit over HDDs: SSDs are far more power efficient, using less power to get more work done.

We measured system level power consumption while testing OPM and calculated power efficiency by dividing each configuration's OPM by the measured power consumption:

Figure 3 shows these results with storage type on the horizontal axis and OPM per watt on the vertical axis. The HDD configuration is again red, the 4x 5100 MAX in light blue and the 8x 5100 MAX in darker blue. In Figure 3, taller is better.

$$\text{Power/Performance Efficiency} = \frac{\text{Orders Per Minute}}{\text{Power Consumption (watts)}}$$

If we consider the HDD configuration OPM/watt as our baseline, we see that the 4x 5100 MAX is 4.7x more power efficient than the HDD configuration [(33.9 OPM/watt) / (7.3 OPM/watt)]. The 8x 5100 MAX configuration is 13.5x more power efficient [(98.2 OPM/watt) / (7.3 OPM/watt)].

Both the 5100 MAX configurations offer a tremendous power efficiency advantage over the HDD configuration.

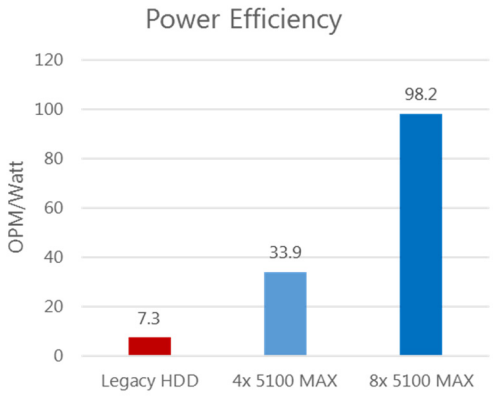

Figure 3: OPM

The Bottom Line

Delayed database response can be very costly, whether accessing mission-critical data, processing order entry/fulfillment or in data acquisition/analysis/management applications. Time can mean money.

Very few IT team members, storage/database architects, or Administrators still expect legacy HDD-based storage to meet the incredible demands of high volume OLTP applications: High performance OLTP demands high performance storage like 5100 MAX.

Many have started to look at storage more holistically – striving for increased OPM, better and more consistent latency as well as improved power efficiency.

On these counts, the 5100 MAX delivers: better OPM, lower and more consistent latency with lower power consumption compared to legacy HDDs OLTP workloads.

Want to learn more? Come visit us on the web:
5100 Product Line (includes the MAX, PRO and MAX families)
Micron's complete SSD line

How We Tested

To ensure a fair assessment of each configuration's capabilities – the maximum OPM one could expect – we took a configuration-specific approach. We wanted to ensure we measured each configuration's OPM at the maximum load the platform could reasonably support (as opposed to comparing OPM and latency at an arbitrarily fixed number of users).

Prior to testing, we established stop conditions. As we tested, we increased the load. If we reached a stop condition, we stopped increasing the load and used the OPM, latency and power consumption values recorded when we reached the stop condition. Stop conditions are in Table 1.

Limit	Stop Condition
CPU Utilized	80%
90th Percentile Transaction Response Time	See Table 2
Disk Write Latency	50ms

Table 1: Stop Condition Limits

CPU utilization: stop at 80%. Many IT organizations plan for platform upgrade when CPU utilization reaches 50% and implement that plan when it reaches 80%.

Transaction	90th Percentile Response Time
New order	5 seconds
Payment	5 seconds
Order status	5 seconds
Delivery	5 seconds
Stock level	20 seconds

Table 2: Threshold Limits

99.9th percentile transaction response time: We set 99.9th percentile transaction response times to the values in Table 2. These each reflect common tolerance limits.

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