Free Your Read-Intensive NoSQL Workloads from Slow HDDs

Micron's Latest-Generation Storage Technology Drives Results with Apache Cassandra®

Overview

Some read-focused NoSQL workloads have been relegated to legacy storage (hard disk drives [HDDs]) because flash affordability was one remaining consideration that put flash benefits beyond the reach of these workloads.

The affordability gap between HDDs and flash narrows with Micron's 5210 ION SSD, a quad-level cell (QLC) technology pioneer.

QLC stores four bits in each NAND cell (33% more than the prior generation), helping drive a more approachable price point for solid state storage. Micron is the first to make QLC benefits available in an enterprise-class SSD[1].

This technical brief highlights the performance[2] advantages of the 5210 ION versus legacy storage (10K RPM 2.4TB hybrid HDDs) in a four-node Apache Cassandra cluster.

Note: Cassandra supports a wide range of deployments. Because QLC is optimized for read-centric workloads, this brief focuses on Cassandra workloads that are also read-centric (see details on these workloads later in this document). You may find some results more relevant than others for your deployment.

Fast Facts

- The 5210 ION cluster showed up to 9X higher Cassandra database read operations per second than a legacy HDD cluster
- The SSD cluster lowered read latency by 86% to 92%
- Micron is a leader in **QLC NAND** and our 5210 ION SSD is the first SSD to bring QLC benefits to enterprise-class SSDs[1]
- Move your read-focused Cassandra workload to SSDs at a more approachable price point

1. Micron® 5210 ION SSD (1.92TB version) used in all testing. Other configurations may give different results.
2. We use the terms database operations per second (OPS) and performance interchangeably in this paper.

Unleash Data-Hungry Workloads

We designed the test process to closely emulate a real-world deployment and usage scenario for a four-node Cassandra database. We focused on standard Yahoo! Cloud Serving Benchmark (YCSB) benchmarks to ensure the results were broadly applicable.

Each test cluster consisted of four nodes and hosted a 1TB Cassandra database – one cluster used 5210 ION SSDs and the other used HDDs. We set the replication factor for the Cassandra database to 3 (this means that there are three copies of the data, and the cluster can sustain the loss of two data nodes while continuing operation).

Figure 1 shows relative performance (including reads, updates, inserts, read/modify/write, etc) of each configuration across four read-centric workloads with different thread counts (taller is better).

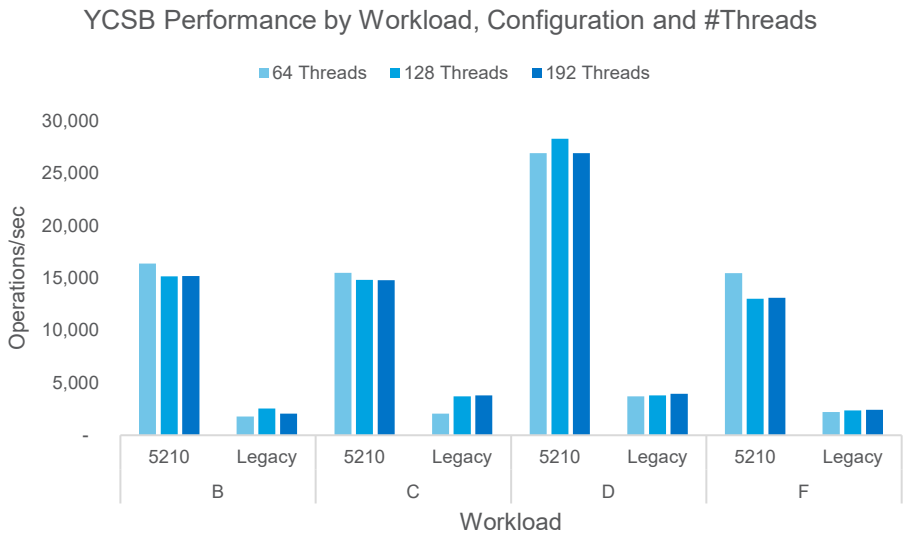

Figure 1: Performance

The 5210 ION test cluster performance advantage ranges from a minimum improvement of about 3.9X to a maximum improvement of about 9.2X.

Build More Responsive Clusters

Many Cassandra deployments rely heavily on fast, consistent responses to queries (lower read latency). We compared the read latency for each configuration by workload at thread counts 64, 128, 192.

Figures 2 shows these results (note that different workloads use different operations—this comparison is read focused, so Figure 2 shows average read latency. In Figure 2, lower is better). 64 threads showed the best results for all configurations.

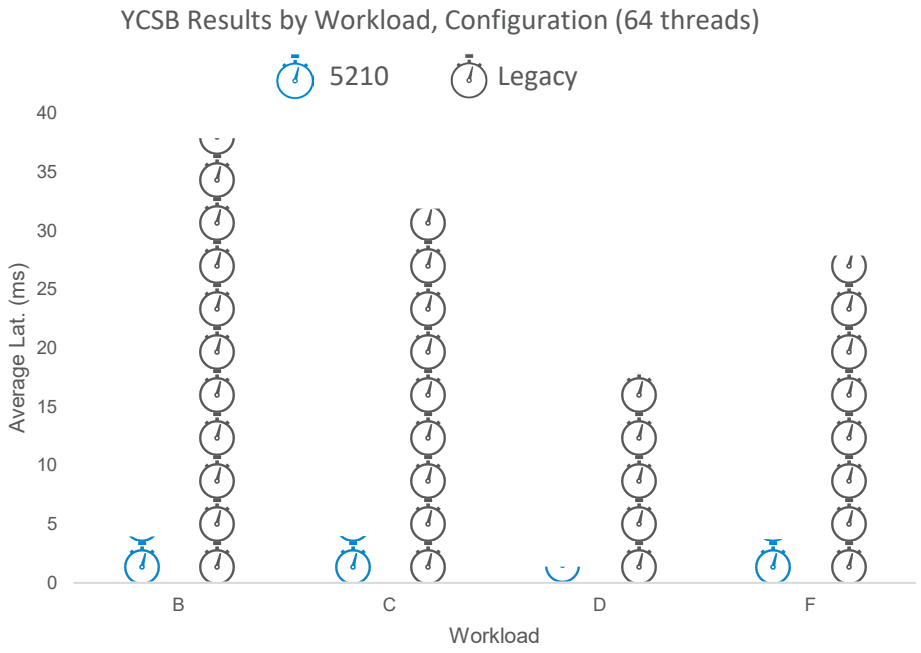

Figure 2: Read Latency

For all tested workloads, the 5210 ION configuration shows lower read latency. In Table 1, the 5210 ION improvement is also shown as a percentage of average read latency reduction.

Workload	5210	Legacy	5210 Improvement
B	4	38	89% Lower
C	4	32	87% Lower
D	2	18	92% Lower
F	4	28	86% Lower

Table 1: Average Read Latency Improvements

The 5210 ION reduced read latency by 86% to 92% compared to the HDD test cluster.

How You Can Use These Results

Emerging applications and workloads are hungry for data—driving new storage demands. Our 5210 ION SSD helps meet these demands with:

- Immediate access to vast numbers of user profiles
- Real-time analytics and business information
- Active archives storing immense data volumes
- Lightning-quick VM backup and restore
- Multinode read-heavy databases
- Real-time media delivery
- Content organization (tagging, writing a very small amount of data)

These applications and workloads share a common thread: they read far more data than they create, and much of their value lies in the ability to read data quickly and efficiently.

Read-focused workloads excel with the 5210 ION, changing the read-centric application landscape and unleashing emerging workloads to deliver results like never before. The 5210 ION enables SSD capacities measured in multiple terabytes (TB), read throughput in hundreds of megabytes per second (MB/s) and density-driven cost effectiveness for high-capacity, ultra-fast, read-focused storage to enable new design opportunities and performance thresholds.

The Bottom Line

High-performance, read-centric SSDs like the 5210 ION can produce amazing results when matched to common, read-focused Cassandra workloads such as those that add metadata (tags) to existing records, access user profiles (for identity validation), update user status (the user population typically wants to read others' status) or records user activity.

We tested two four-node Cassandra clusters for database performance and read responsiveness across common, read-focused workloads. We built a legacy cluster using four 2.4TB 10K RPM HDDs (RAID 0) in each node and an SSD cluster with four 5210 ION QLC SSDs (1.92TB each[3]). The 5210 ION test cluster showed a significant increase in database performance with far lower read response time.

Many emerging workloads share a common thread: they read far more data than they create, and they must read it quickly and efficiently. When these workloads are cost-sensitive, we've had to compromise, relegating them to slow legacy storage, which compromises results.

Micron's 5210 ION storage helps bridge the affordability gap, ushering more read-centric workloads into SSDs to drive them further.

Learn more about QLC technology and its transformative effect on your business at micron.com. Stay up to date on what's trending in storage by reading Micron's Storage Blog, following us on Twitter @MicronStorage, or connecting with us on Linkedin.

3. This paper focuses on a Micron 1.92TB 5210 SSD. Other configurations may give different results. We did not test YCSB workload E because it is not universally supported.

How We Tested

We initially created the database using YCSB workload A's load parameter to generate a dataset of approximately 3TB (including replication). The database was then backed up to a separate location over an NFS mount point. For each configuration tested, we restored the databased from this backup to start every test from a consistent state.

Testing Parameters

Parameters	Value	Description
Number of threads	64, 128, 192	Load on the database
Fieldcount	10	Standard 1KB record size
Recordcount	1 Billion	Number of records in the database
Operationcount	100 Million	Dataset size within database.

Table 2: Parameters

We compared two four-node Cassandra test cluster configurations using the Yahoo! Cloud Serving Benchmark (YCSB) read-centric workloads B, C, D and F[3] (we did not test additional workloads containing significant write traffic as these workloads may be better served by other SSDs in Micron's portfolio).

To unleash real value, plan your next high-capacity, high-demand Cassandra cluster to support amazing capacity and provide compelling results with the 5210. We tested our 5210 ION against a legacy configuration:

Figure 3a: 5210 ION Configuration – Four 1.92TB SSD Per Node

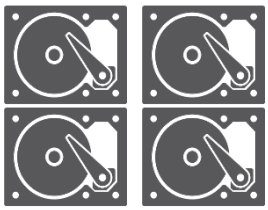

Figure 3b: Legacy Configuration – Four 10K RPM 2.4TB Hybrid HDDs Per Node