Using QLC SSDs to Improve Cost/Performance Tradeoffs for Warm Data

Kent Smith
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Santa Clara, CA
30 Trends Driving Data Growth

- Fraud Prevention
- Artificial Intelligence
- Machine Learning
- Virtual & Augmented Reality
- Big Data & Real-Time Analytics
- Personalized Medicine
- Media Streaming
- Online Education & Healthcare Delivery
- Real-Time Inventory
- Smart Home
- Programmatic Advertising
- Surveillance
- Genomic Analysis
- Wearables
- Social Media
- Automated Manufacturing
- Cryptocurrency
- Self-Driving Cars
- Deep Learning
- Dynamic Pricing
- Drones
- eSports
- Cloud Computing
- 5G Connectivity
- Internet of Things
- Dynamic Pricing
- Internet of Things
- Smart Ag
- 163 Zetabytes by 2025 (IDC)
This data needs to be read and analyzed quickly. Not rewritten repeatedly.
AI Is Shifting the Data Center IO Pattern

<table>
<thead>
<tr>
<th>Application</th>
<th>Read-to-write ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional Data Center</td>
<td>4:1</td>
</tr>
<tr>
<td>Deep Learning for AI</td>
<td>50000:1</td>
</tr>
</tbody>
</table>

Source: EnterpriseStorageforum.com: "Data Storage, AI, and IO Patterns"
The Evolution of Enterprise SSDs


Note: Dates represent when Micron® enterprise SSDs launched with each generation of NAND technology.

- **SLC** 2007: Expensive, Low Capacity
- **MLC** 2011
- **TLC** 2016
- **QLC** 2018: World’s first QLC SSD! Affordable, High Capacity
QLC = Fast Capacity For Less

SLC
1 Bit Per Cell
First SSD NAND technology

MLC
2 Bits Per Cell
100% increase in bit density

TLC
3 Bits Per Cell
50% increase in bit density

QLC
4 Bits Per Cell
33% increase in bit density

Lower cost per GB
Fewer writes per cell
Endurance Needs are Decreasing

Enables Industry Expansion to QLC

4/5 of ALL enterprise SSDs shipped worldwide in 2018 were ≤ 1 DWPD

Source: Forward Insights Datacenter, May 2019
Tiering with QLC SSDs

QLC Is Designed To:
- Augment TLC; not replace it
- Transition HDDs to SSDs*

*55 million 7.2K+ RPM HDD shipments expected in 2019; QLC pricing is in striking distance to these HDDs
### Understanding Best-Fit Workloads for QLC SSDs

<table>
<thead>
<tr>
<th>Block Size</th>
<th>Read-Intensive Workloads</th>
<th>Mixed Workloads</th>
<th>Write-Intensive Workloads</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100/0¹</td>
<td>60/40</td>
<td>30/70</td>
</tr>
<tr>
<td></td>
<td>90/10</td>
<td>50/50</td>
<td>20/80</td>
</tr>
<tr>
<td></td>
<td>80/20</td>
<td>40/60</td>
<td>10/90</td>
</tr>
<tr>
<td></td>
<td>70/30</td>
<td></td>
<td>0/100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Small or Random</th>
<th>4</th>
<th>8</th>
<th>16</th>
<th>32</th>
<th>64</th>
<th>128</th>
<th>1024</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read/Write Ratio</td>
<td>1</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>

**QLC SSD Best Fit Zone**

**TLC SSD Best Fit Zone**

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**Workloads in QLC Best-Fit Zone:**

<table>
<thead>
<tr>
<th>Workload</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read-Intensive AI Data Lakes</td>
<td>43%</td>
</tr>
<tr>
<td>Machine &amp; Deep Learning Data Lakes</td>
<td>13%</td>
</tr>
<tr>
<td>Real-Time Analytics &amp; Big Data</td>
<td>42%</td>
</tr>
<tr>
<td>Ceph Large Block &amp; Object Stores</td>
<td>36%</td>
</tr>
<tr>
<td>SQL Business Intelligence</td>
<td>9%</td>
</tr>
<tr>
<td>NoSQL MongoDB, Cassandra</td>
<td>20%</td>
</tr>
<tr>
<td>Media Streaming CDNs</td>
<td>14%</td>
</tr>
</tbody>
</table>

1. Read/write ratio
2. Based on industry analysis from IDC, Gartner, Statista, Forbes
Performance Sensitive Workloads Historically Run on HDDs

These workloads:
- Read data 90+% of the time
- Rely heavily on random reads & sequential writes
- … yet have typically been run on HDDs
10 Workloads Moving from HDDs to QLC

SATA QLC Enables You to Immediately Replace HDDs in Performance-Sensitive Workloads

SATA QLC offers:

- Up to 450x faster performance
- Lowest possible TCO of any SSD
- Same interface as HDDs for platform continuity
- Architected for HDD environments to exceed requirements

AI/ML/DL Data Lakes
Edge Analytics (5G, etc.)
Analytics & Big Data (Hadoop)
Object Stores (Ceph)
SQL Databases (BI/DSS)

NoSQL Databases (Cassandra)
CDN
Cloud Services
vSAN Capacity Tier
Financial Regulatory & Compliance Storage

AI/ML/DL
Edge Analytics
Analytics & Big Data
Object Stores
SQL Databases
NoSQL
CDN
Cloud Services
vSAN
Financial

5210 ION
2.5-inch SSD | SATA

Flash Memory Summit
HDD Throughput Limits & Their Impact on Reliability

- HDD failure rates increase once HDDs hit their **Workload Rating**, an HDD metric of total throughput.
- **Workload Rating** as defined on HDD datasheets: “Maximum rate of <550TB/YR (5-year warranty). Workloads exceeding the annualized rate may degrade the drive MTTF and impact reliability.”
- HDD throughput limits apply to reads and writes, whereas SSDs only wear when writing.

The Impact of HDD Throughput Limits & Reliability Concerns

<table>
<thead>
<tr>
<th>Drive</th>
<th>Capacity</th>
<th>Workload Rating (TB/Year)</th>
<th>DWPD</th>
<th>Advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micron® 5210 (QLC)</td>
<td>7.68TB</td>
<td>2,242*</td>
<td>0.80</td>
<td>N/A</td>
</tr>
<tr>
<td>(and only limited on writes)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vendor B 7.2K HDD</td>
<td>8TB</td>
<td>550</td>
<td>0.19</td>
<td>4x</td>
</tr>
<tr>
<td>Vendor B 7.2K HDD</td>
<td>10TB</td>
<td>550</td>
<td>0.15</td>
<td>5x</td>
</tr>
<tr>
<td>Vendor B 7.2K HDD</td>
<td>12TB</td>
<td>550</td>
<td>0.13</td>
<td>6x</td>
</tr>
<tr>
<td>Vendor C 7.2K HDD</td>
<td>14TB</td>
<td>550</td>
<td>0.11</td>
<td>7x</td>
</tr>
</tbody>
</table>

*Numbers in blue aren’t on datasheets, but can be calculated as follows based on sequential transfers:

**Workload Rating**: DWPD x capacity x 365 days per year

**DWPD**: (Workload Rating / 365 days per year) / capacity
5210 Best Fit Zone

Workloads in this Zone
- CDN
- Analytics & big data (Hadoop)
- Object stores (Ceph)
- Edge analytics (5G, etc)
- AI/ML/DL data lakes
- SQL databases (BI/DSS)
- NoSQL databases (Cassandra)
- Cloud services
- vSAN capacity tier
- Financial regulatory & compliance storage

Assumptions
- 4k aligned random writes
- 128k sequential writes

Read the Whitepaper
"Comparing SSD & HDD Endurance in the Age of QLC SSDs"

Of all the writes you do, what percent are sequential vs. random in nature?

<table>
<thead>
<tr>
<th>Type of Writes</th>
<th>DWPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% random</td>
<td>0.20</td>
</tr>
<tr>
<td>50% seq. 50% random</td>
<td>0.25</td>
</tr>
<tr>
<td>70% seq. 30% random</td>
<td>0.13</td>
</tr>
<tr>
<td>80% seq. 20% random</td>
<td>0.16</td>
</tr>
<tr>
<td>90% seq. 10% random</td>
<td>0.09</td>
</tr>
<tr>
<td>100% sequential</td>
<td>0.05</td>
</tr>
</tbody>
</table>

- Up to 6x delta

1. Compared to Vendor B 12TB HDD

5210 vs. 7.2K HDD Warranted Endurance Comparison
Don’t just take our word for it.
Test 5210 against HDDs in your performance-sensitive workloads and compare the difference.