SOLIDIGM™

4 reasons why QLC is Ready for Mainstream Workloads

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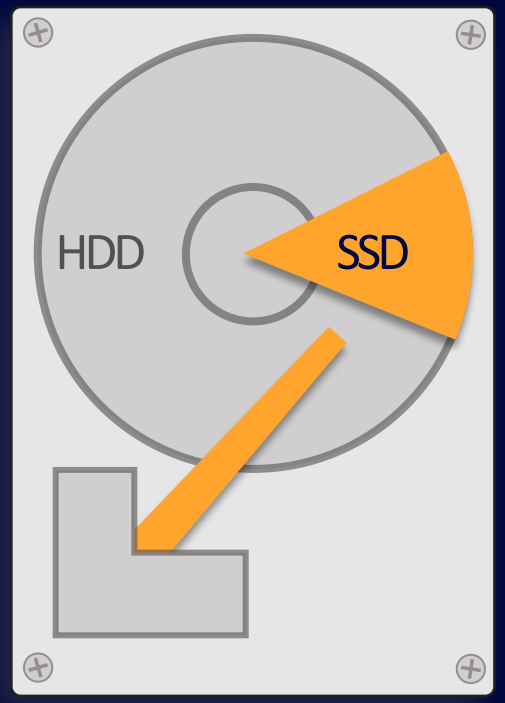
QLC SSDs fill a need for efficient storage

Between 85 and 90% of all datacenter data is still stored on HDDs[1]



Modern workloads create storage cost & performance gaps

TLC NAND
High performance,
not optimized for cost and capacity

Cost Gap

QLC Need

Performance Gap

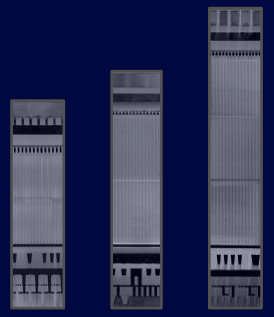
Hard Disk Drives
Cost efficient,
performance and operational deficiencies

See appendix for footnotes.

4 reasons why Solidigm™ QLC is ready for mainstream workloads

01

MATURE TECHNOLOGY with broad adoption

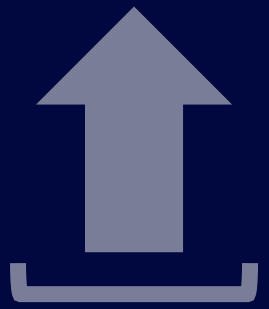


02

AMPLE ENDURANCE for real-world workloads

03

READ PERFORMANCE on par with entry TLC

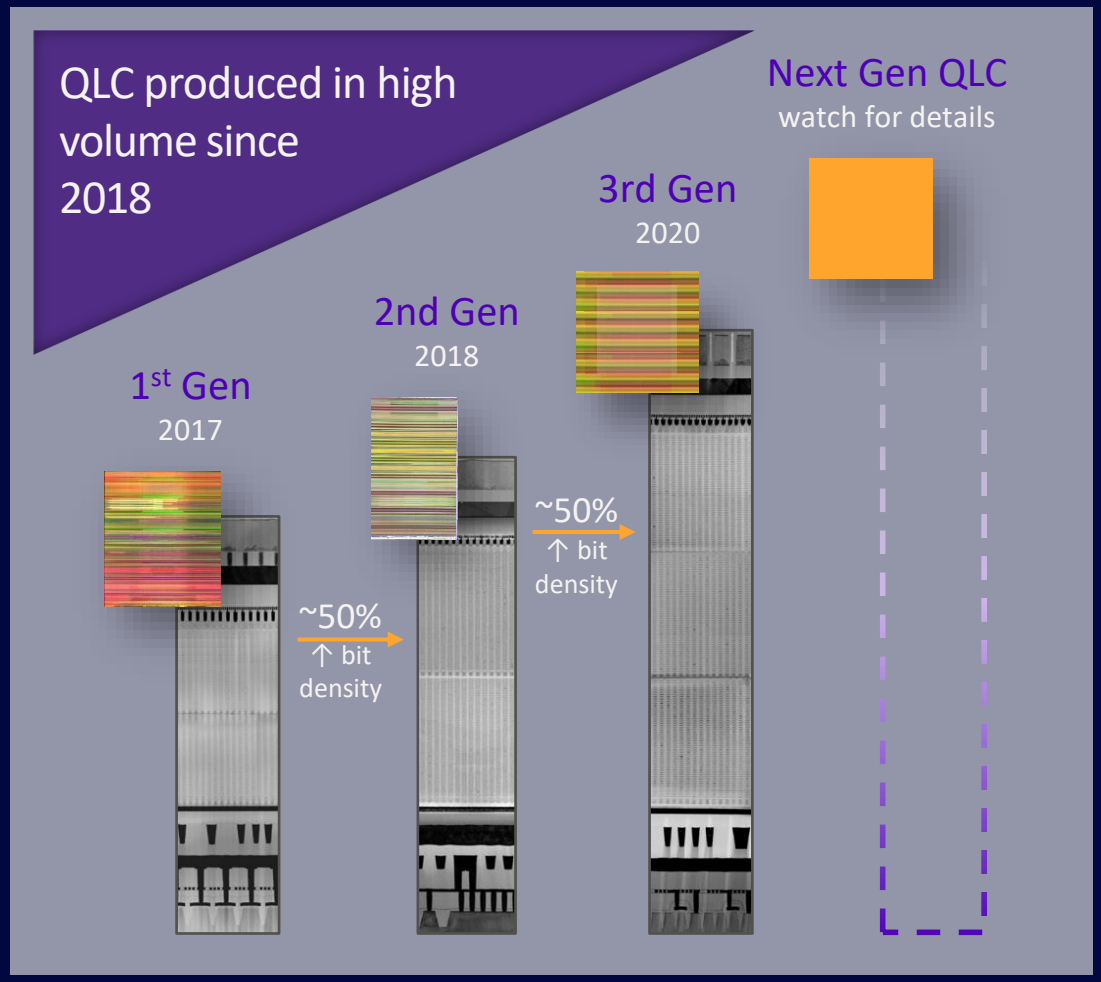


04

PROVEN VALUE across a broad range of workloads

Mature QLC technology with broad adoption

Continuous areal density improvement[2]



Broad & growing industry adoption

CLOUD

ENTERPRISE

ODM

STORAGE INNOVATORS

Baidu 百度 · ByteDance · CLOUDFLARE · DigitalOcean · Dropbox · Kingsoft Cloud · LinkedIn · phoenixNAP GLOBAL IT SERVICES · salesforce · Uber · CISCO · DELL Technologies · Hewlett Packard Enterprise · SUPERMICRO · ASRock Rack · GIGABYTE · Quanta Computer · lightbits · PLIOPS EXTREME DATA PROCESSOR · VAST

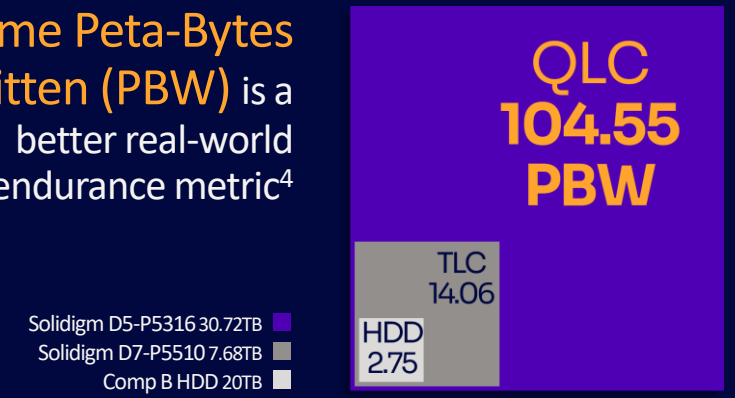
See appendix for footnotes.

QLC delivers ample endurance for today's workloads

only 15% used

"…for the vast majority of enterprise users, a move towards QLC's PE cycle limits poses no risks, as 99% of systems use at most 15% of the rated life of their drives."[3]

Lifetime Peta-Bytes Written (PBW) is a better real-world endurance metric[4]



Workload-specific endurance calculations

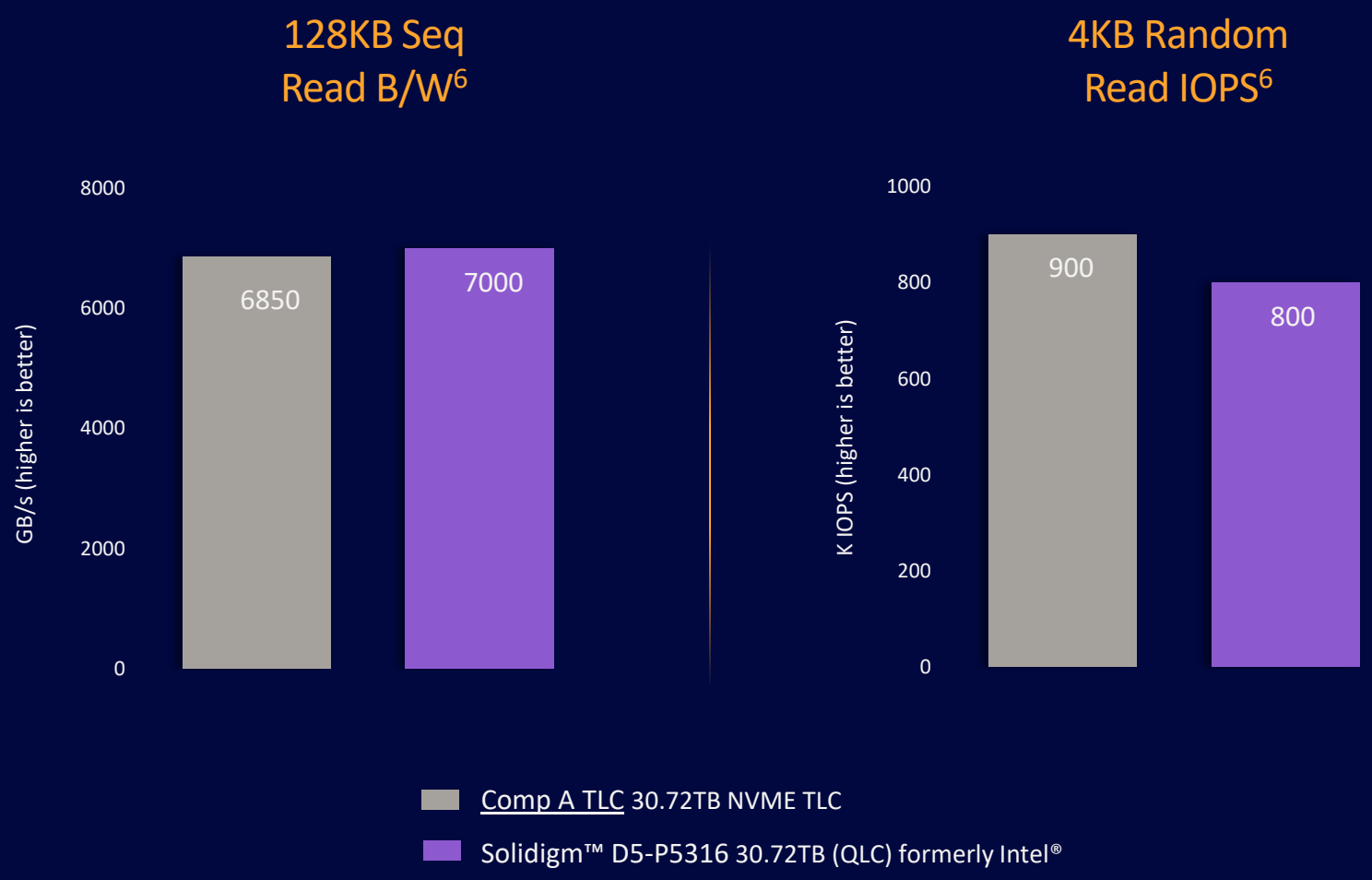
CDN/Streaming
0.17 DWPD
18.9 Petabytes written

OLTP Database
0.01 DWPD
1.2 Petabytes written

Email/Messaging
0.01 DWPD
1.1 Petabytes written

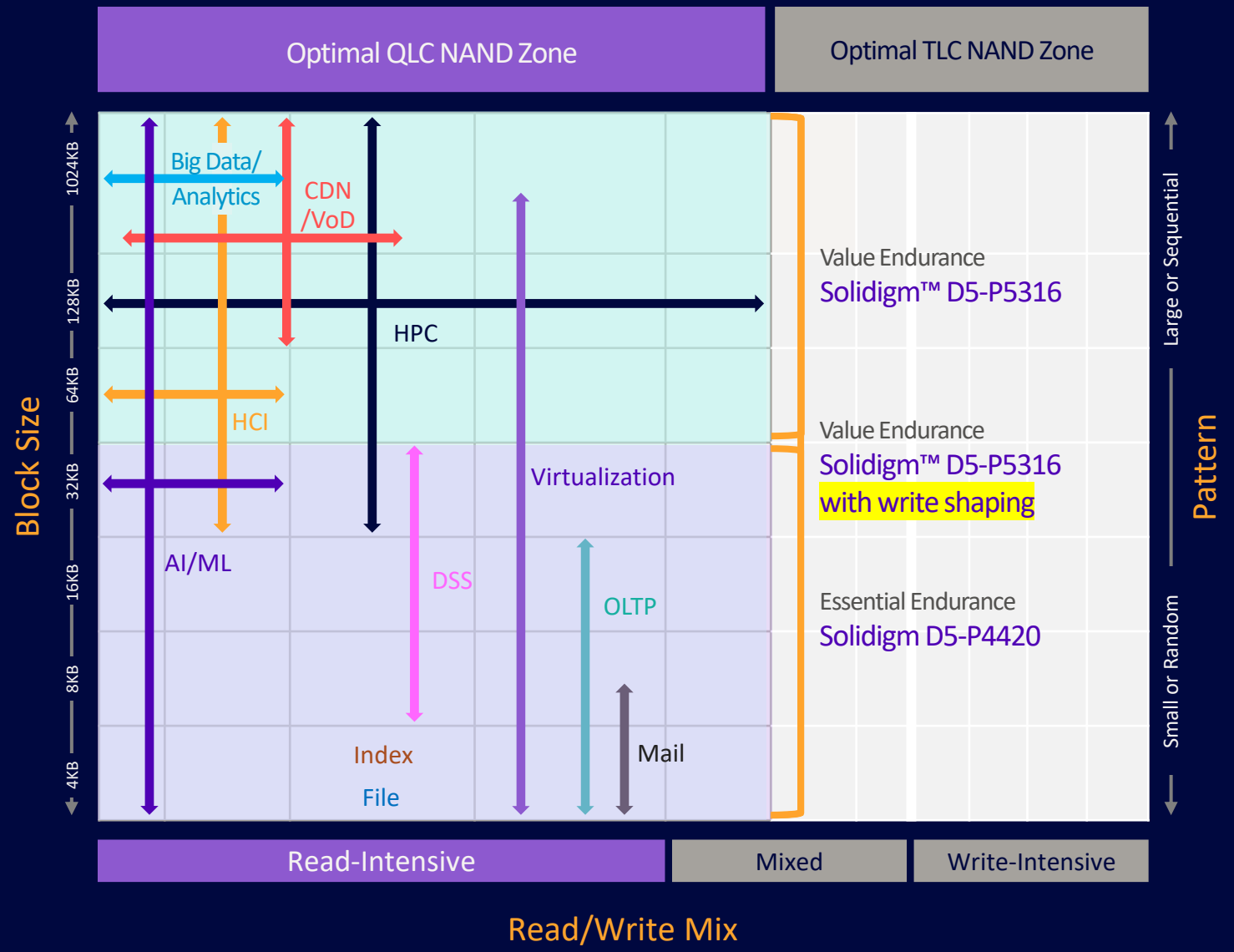
See appendix for footnotes.

QLC read performance is on par with entry-TLC



See appendix for footnotes.

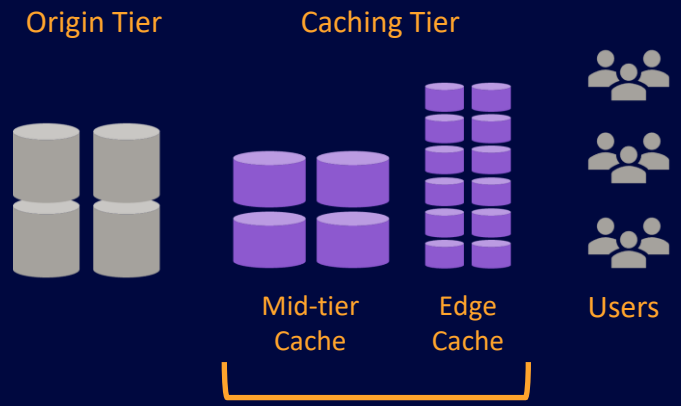
Read-intensive workloads needing rapid access to vast datasets are ideal for QLC NAND SSDs



Examples shown may not represent all QLC fit opportunities. For more information see the QLC Workload Guide.

Proven QLC value for Content Delivery Networks (CDN)

Example architecture

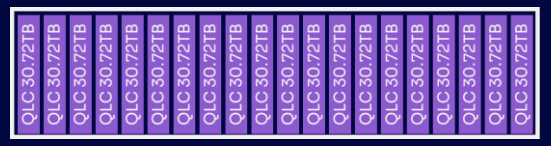


QLC fit

CDN I/O characterized by up to **95%** read-intensive operations[7]

Mid-tier CDN + QLC TCO Savings Example

Solidigm™ D5-P5316 30.72TB
(formerly Intel®)



614TB capacity and 190Gbps per server,
67 total servers required

vs

Hybrid - TLC SSD + HDD Arrays

111TB capacity and 51Gbps per server,
331 total servers required

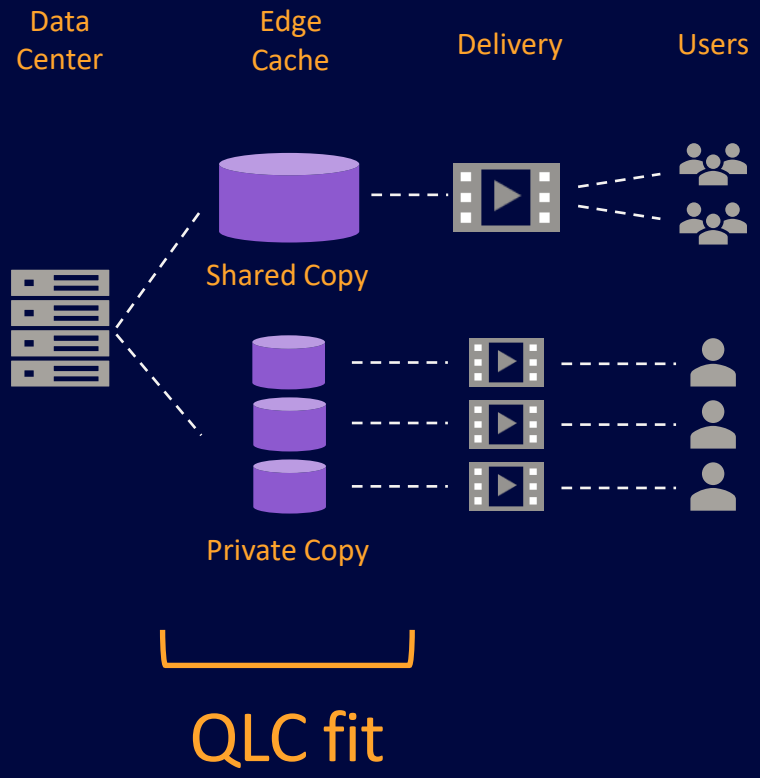
nearly **5x** greater server consolidation[7]

up to **14%** lower 5-year estimated TCO[7]

See appendix for footnotes.

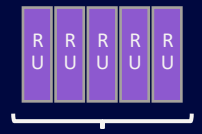
Proven QLC value for Cloud DVR (cDVR)

Example architecture



cDVR + QLC TCO Savings Example

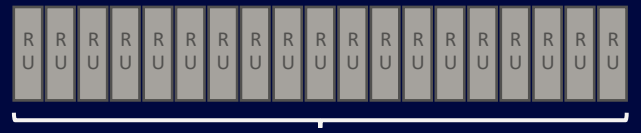
Solidigm™ D5-P5316 30.72TB
(formerly Intel®)



meet 43.3TB capacity and 3.44Tbps throughput,
5 racks @ 33 rack units/rack

vs

Solidigm™ D3-S4511 7.68TB (SATA)
(formerly Intel®)



meet 43.3TB capacity and 3.44Tbps throughput,
19 racks @ 33 rack units/rack

nearly

4x

smaller rack footprint[8]

up to

36%

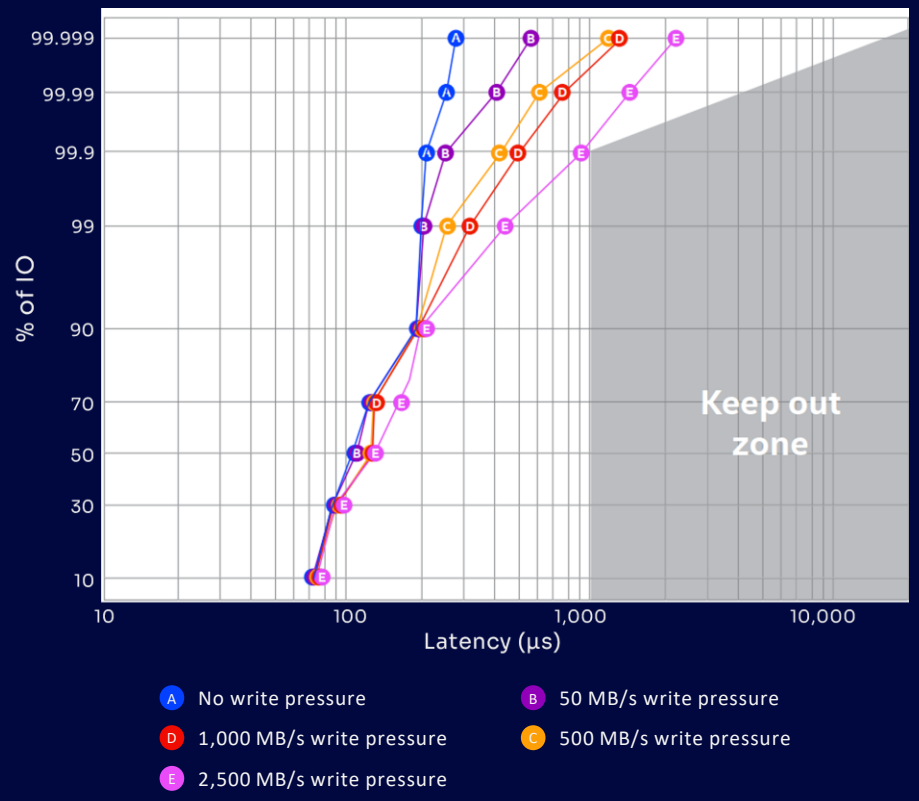
lower 5-year estimated TCO[8]

See appendix for footnotes.

Proven QLC value for HPC and AI (using DAOS)

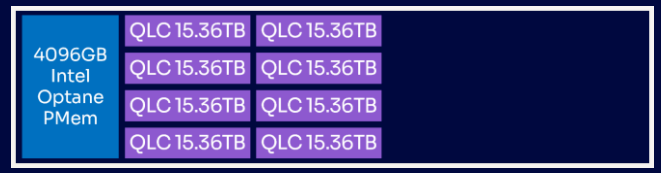
QoS performance

4K Random Read QoS under Write Pressure
Solidigm™ D5-P5316 (formerly Intel®) on 3rd Gen Intel® Xeon™ Scalable processor, DAOS 1.0



DAOS + QLC TCO Savings Example

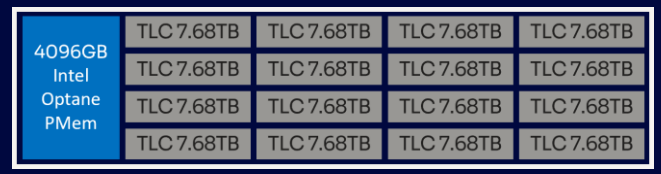
Solidigm™ D5-P5316, 8x 15.36TB
(formerly Intel®)



DAOS server with 4TB Intel® Optane™ PMem,
128TB total storage

vs

Solidigm™ D3-S4511, 16x 7.68TB (SATA)
(formerly Intel®)



DAOS server with 4TB Intel® Optane™ PMem,
128TB total storage

meet

QoS

Service Level Agreements[9]

up to

22%

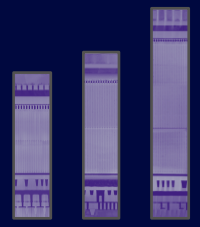
lower DAOS engine storage costs[9]

See appendix for footnotes.

Solidigm™ QLC is ready for mainstream workloads

01

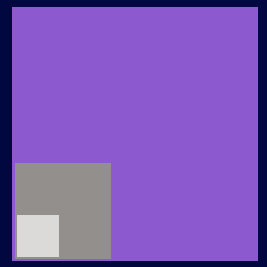
MATURE TECHNOLOGY with broad adoption



since 2018

02

AMPLE ENDURANCE for real-world workloads



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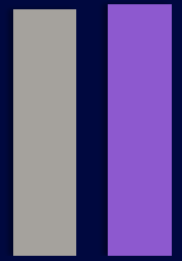

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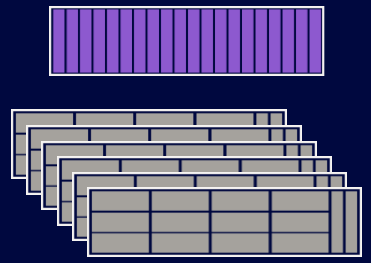
PROVEN VALUE across a broad range of workloads

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Appendix

[1] Source - Solidigm internal analysis and consensus of industry analyst estimates.

[2] Source – Intel. Dates are based on Intel technology announcements.

[3] Sources – Solidigm™ (formerly Intel®) SSD D5-P5316 30.72TB https://ark.intel.com/content/www/us/en/ark/products/208269/intel-ssd-d5p5316-series-30-72tb-2-5in-pcie-4-0-x4-3d4-qlc.html; Solidigm™ (formerly Intel®) SSD D7-P5510 7.68TB https://ark.intel.com/content/www/us/en/ark/products/205382/intel-ssd-d7p5510-series-7-68tb-2-5in-pcie-4-0-x4-3d4-tlc.html ; Western Digital Ultrastar DC HC650 20TB https://documents.westerndigital.com/content/dam/doc-library/en_us/assets/public/western-digital/product/data-center-drives/ultrastar-dc-hc600-series/data-sheet-ultrastar-dc-hc650.pdf

[4] Source - University of Toronto study of 1.4 million industry SSDs in Enterprise Storage Deployment. A Study of SSD Reliability in Large Scale Enterprise Storage Deployments , https://www.usenix.org/conference/fast20/presentation/maneas

[5] Source – Solidigm. SSD Endurance Estimator https://estimator.intel.com/ssdendurance/. Calculated using Solidigm™ (formerly Intel®) D5-P5316 30.72TB. Workload input parameters – Streaming: 256K Random, 90R/10W, QD 32, 20 duty cycle; OLTP Database: Email: 4K Random, 70R/30W, QD 32, 20% duty cycle. Estimated life does not represent warranty terms.

[6] Source as noted – Solidigm™ (formerly Intel®) D5-P5316 30.72 TB data sheet https://ark.intel.com/content/www/us/en/ark/products/208269/intel-ssd-d5p5316-series-30-72tb-2-5in-pcie-4-0-x4-3d4-qlc.html; Comp A Kioxia CM6-R data sheet https://business.kioxia.com/en-us/ssd/enterprise-ssd/cm6-r.html

[7] CDN-based proof points: Source – Solidigm™ (formerly Intel®). Solution brief @ https://www.intel.com/content/dam/www/central-libraries/us/en/documents/replace-legacy-storage-in-cdn-with-qlc-ssd-brief.pdf. Intel SSD pricing shown based on Intel Recommended Customer Price (RCP) as of September 20, 2021. Actual price can vary and may not reflect the pricing used in the TCO model.

[8] cDVR-based proof points: Source – Solidigm™ (formerly Intel®). Solution brief @ https://www.intel.com/content/www/us/en/products/docs/storage/modernize-cloud-with-qlc-3d-nand-brief.html?wapkw=cloud%20dvr . Intel SSD pricing shown based on Intel Recommended Customer Price (RCP) as of September 20, 2021. Actual price can vary and may not reflect the pricing used in the TCO model.

[9] DAOS-based proof points: Source – Solidigm™ (formerly Intel®). Solution brief @ https://www.intel.com/content/www/us/en/high-performance-computing/daos-high-performance-storage-brief.html?wapkw=daos. Intel SSD pricing shown based on Intel Recommended Customer Price (RCP) as of September 20, 2021. Actual price can vary and may not reflect the pricing used in the TCO model.