

## Solutions Brief

CLOUD STORAGE  
D5-P5336

# A CSAL-Based Reference Storage Platform

### Our partners



Open-source building blocks used for storage solutions are a complex mix of parts that are challenging to assemble and use. This complexity often hampers the rapid development, assessment, and deployment of these solutions. To overcome this problem, Solidigm has developed a reference storage platform in collaboration with Intel, StarWind, other industry partners, and the Storage Performance Development Kit (SPDK) community. This platform will help foster industry-wide collaboration and enable easy evaluation and adoption of technologies, such as data placement technologies (for example, Zoned Namespaces [ZNS] and Flexible Data Placement [FDP]), that are currently under development.

The reference platform uses commodity servers that are paired with an open-source software stack composed of SPDK and a Cloud Storage Acceleration Layer (CSAL) as the host-based flash translation layer (FTL). This solution brief discusses how Solidigm used this reference platform to demonstrate the unprecedented total cost of ownership (TCO) benefits of high-density storage from the newly released Solidigm™ D5-P5336 61.44 TB quad-level cell (QLC) SSD.

## Benefits of the reference storage platform

The reference storage platform is an open, extensible, high-performance platform that enables hardware and software vendors to rapidly innovate (using high-density QLC, infrastructure processing units [IPUs], and data placement technologies, among other technologies). In addition, the platform enables system integrators and end customers to evaluate and adopt these innovations seamlessly in a fully implemented solution interface. Platform vendors and independent software vendors (ISVs) can extend the capability of the open-source platform with value-added innovations to create their own proprietary appliances and solutions.

## What can CSAL accomplish?

The CSAL host-based FTL extends the use of Solidigm high-density QLC SSDs to mixed workloads. CSAL achieves this through the following four core capabilities:

- 1. Write shaping to enable a reduced SSD/DRAM footprint:** Solidigm hyper-dense SSDs can help reduce DRAM costs while maintaining TLC read performance. CSAL shapes writes for emerging data placement interfaces that match the indirection unit (IU) size, bringing TCO advantages to mixed workloads.
- 2. Pooling to increase capacity and performance utilization:** CSAL enables the sharing of large SSDs among multiple cloud applications/tenants, thereby increasing capacity and performance utilization.
- 3. RAID to enhance data protection and reliability:** Under development in CSAL is a full-stripe RAID5 implementation that is 2x more efficient than traditional RAID5 in improving data protection and reliability.<sup>1</sup>
- 4. Reducing write amplification in multi-tenant environments:** Mixed data placement can cause excessive write amplification in multi-tenant cloud environments. Under development in CSAL is the integration of data placement technologies. By optimizing data placement, aggregating writes, and scheduling input/output (I/O) operations, CSAL helps achieve true multi-tenant isolation and helps improve QLC performance and endurance.

## Testing the platform with Solidigm QLC SSDs

Improved density has led to a significant TCO advantage. For example, by replacing HDD-based big data local disk instance 2nd generation local-disk storage nodes with the Solidigm D5-P5316 QLC SSDs in their big data local disk instance 3rd generation nodes, Alibaba saw twice the performance and density over the 2nd generation.<sup>2</sup> The D5-P5336 61.44 TB QLC SSD continued this trend by delivering 4x the density of the D5-P5316, with a 2x TCO reduction through lower capital expenditures (CapEx), a smaller data center footprint, and subsequently less demand for maintenance personnel and associated equipment, cabling, and power.<sup>1</sup>

### Test configuration

To objectively evaluate its new highest density QLC SSDs using the reference platform, Solidigm compared a system with 10 Solidigm TLC drives without CSAL versus a 3 SLC + 7 QLC configuration using CSAL (this configuration used three 800 GB Solidigm first-generation SLC SSDs and seven 61.44 TB D5-P5336 SSDs as the capacity tier). Solidigm used a 4K 70/30 read/write workload to drive 80 percent utilization of the 100 Gbps network. CSAL utilizes SLC SSDs as a cache/write buffer, enabling efficient shaping of write workloads into sequential writes (see Figure 1).

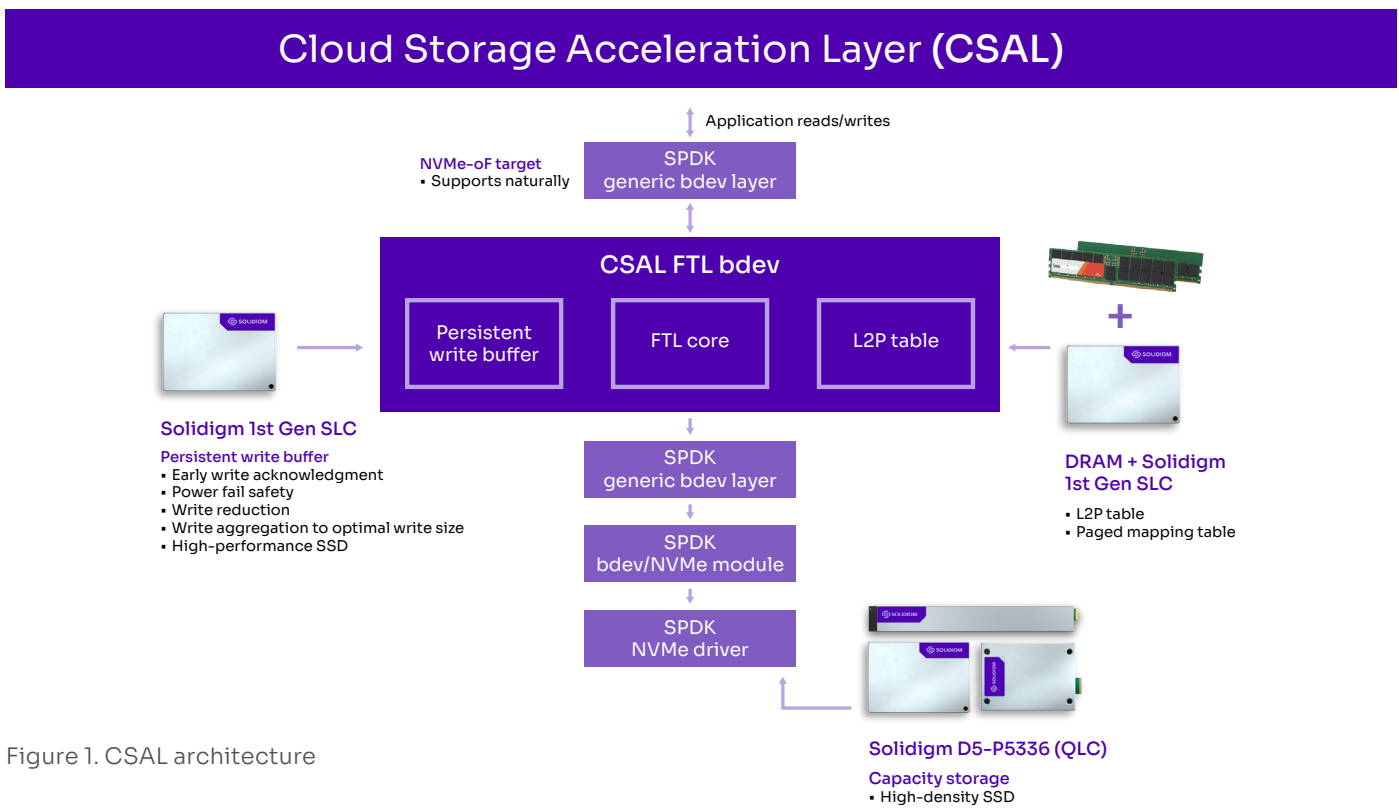


Figure 1. CSAL architecture

Both configurations were able to achieve the desired network saturation. While the TLC SSDs can deliver higher raw performance, the network bottleneck leaves the surplus bandwidth unutilized, which essentially led to both configurations delivering the same performance (see Table 1).

Table 1. Test results

	10 x 15.36 TB Solidigm D7-P5520 TLC SSDs	3 x 800 GB Solidigm SLC SSDs + 7 x 61.44 TB Solidigm D5-P5336 QLC SSDs
Total available capacity	138 TB	344 TB
Raw aggregate read/write bandwidth	14 GB/s	10.3 GB/s
Network bound	11.4 GB/s	11.4 GB/s
Virtual drive capacity	16 TB	16 TB
Virtual drives per node	8	21
Minimum (demanded, delivered) performance per virtual drive	500 MB/s/16 TB	500 MB/s/16 TB

Solidigm developed an internal model to quantify the TCO advantage of D5-P5336 QLC SSD density. A high-level comparison in Table 2 shows that the D5-P5336 QLC SSD can deliver the same performance at 35% lower TCO than the TLC configuration.

Table 2. TCO comparison

	10 x 15.36 TB Solidigm D7-P5520 SSDs	3 x 800 GB Solidigm SLC SSDs + 7 x 61.44 TB Solidigm D5-P5336 QLC SSDs
1x drive capacity	15,360 GB	61,440 GB
Total storage capacity per node	138 TB	344 TB
Incremental cost for compute (vCPU + host DRAM) and storage (SLC + QLC)	Base	+\$14K
Operating expense per node (five years)	Base	Base
Data center tax per node (five years)	Base	Base
Virtual drive capacity	16 TB	16 TB
Virtual drives per node	8	21
Percent TCO savings per virtual drive (five years) over TLC	Base	35%

Solidigm invites platform vendors and end users to use the reference storage platform in their appliance and solution implementations. Innovators across the storage industry can use the reference platform and build upon it, ensuring a robust platform to showcase, evaluate, and accelerate the adoption of new storage solutions.



Try the reference storage platform today.

For reference, read the white paper, [“Achieving Optimal Performance and Endurance on Course IU SSDs.”](#)



<sup>1</sup>Based on Solidigm internal analysis.

<sup>2</sup>Intel. “A Media-Aware Cloud Storage Acceleration Layer (CSAL) Cache Solution with Intel® Optane™ SSDs for Alibaba ECS Local Disk D3C Service.” January 2023. [www.intel.com/content/www/us/en/content-details/765062/a-media-aware-cloud-storage-acceleration-layer-csal-cache-solution-with-intel-optane-ssds-for-alibaba-ecs-local-disk-d3c-service.html](https://www.intel.com/content/www/us/en/content-details/765062/a-media-aware-cloud-storage-acceleration-layer-csal-cache-solution-with-intel-optane-ssds-for-alibaba-ecs-local-disk-d3c-service.html).

Note: The Solidigm D5-P5316 is part of the storage configuration on the Intel platform discussed in this paper.

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