Solution Brief

Intel® QLC 3D NAND Data Center Storage
Content-Delivery Networks

Replace Legacy Storage in Content Delivery Networks with Efficient, Cost-Effective Intel® QLC 3D NAND SSDs

Intel QLC 3D NAND SSDs are ideal for reducing costs while delivering efficient scalability to grow with content and users.

Intel QLC 3D NAND SSDs optimize CDN server efficiency and performance

Intel® QLC 3D NAND SSDs, built on a proven floating gate technology, include a PCIe 4.0 controller and modern firmware to enable large-capacity drives with exceptional read performance for warm data. As a result, these drives can replace hybrid TLC NAND solid state drive (SSD) and hard disk drive (HDD) configurations in certain deployments to realize significant benefits in server consolidation and total cost of ownership (TCO) savings.

As video-on-demand grows in popularity, storage needs to keep up

More and more consumers are turning to streaming media for entertainment. Netflix recorded more than 200 million subscribers worldwide in 2020, an increase of 37 million from 2019.[1] Hulu reported 35.4 million video-on-demand subscribers in Q1 2021, up 30 percent year-over-year.[2] Overall, the streaming market has grown into a multi-billion-dollar industry over the last decade.

Video-on-demand (VoD) content providers have had to respond to the increase in subscribers by spending more to expand their content libraries. In addition, the industry is quickly moving to provide consumers with richer content, which—combined with more users—results in a massive uptick in data to store and deliver. For example, if a given 720p video consumes 2–3 GB of storage, a 1080p version of the same video consumes about 4–5 GB, thereby nearly doubling the amount of streaming data. That massive and expanding data needs to be stored efficiently in order to limit costs for content providers and to meet customer service levels.

Moving content closer to the edge

Mid-tier and edge servers are used to move content closer to end users in order to optimize customer experiences and reduce overall content delivery network (CDN) cost (see Figure 1). These servers drive a read-intensive, large-block storage workload with a focus on system-level latency to improve the user experience (UX). Mid-tier and edge servers also need to meet locality constraints in terms of space, power, and cooling.

To meet these requirements, storage architects need to take into account the unique characteristics inherent to VoD content. Workloads are very read-intensive (up to 95 percent). Writes, which generally only happen during low-write use periods when new content is uploaded, are highly sequential. Both reads and writes typically consist of large block sizes of up to 128K.

Both mid-tier and edge scenarios share similar challenges, including the need to:

- Optimize space and operational efficiency
- Solve for throughput efficiency
- Scale to more content, richer content, and more users within locality constraints

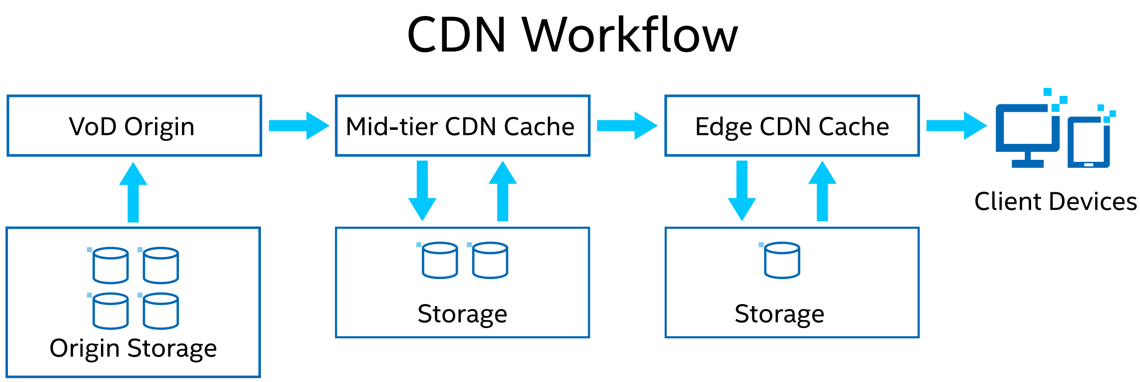

Figure 1. VoD content providers stage content on mid-tier and edge servers to improve the UX.

Deploying the right storage for VoD workloads

Given those characteristics, what would be the ideal storage to solve CDNs' most pressing needs while providing scalability for growth? While storage configurations can vary, most commonly, hybrid arrays of TLC NAND SSDs and HDDs are found in both the mid-tier and edge. But both HDDs and TLC NAND SSDs have significant drawbacks for CDNs looking to meet service requirements in the most cost-effective way.

HDDs are space-inefficient and have a high operating cost. Additionally, their poor performance means they must be paired with TLC NAND SSDs to achieve required throughput. TLC NAND SSDs have ample performance but are not cost-optimized. Therefore, they are frequently not the best choice for CDNs looking to optimize cost per throughput.

Reliable, cost-effective performance for CDN workloads

Intel® QLC 3D NAND SSDs are an ideal fit for VoD workloads in both mid-tier and edge locations because the quad-level cell (QLC) NAND drives offer read performance that is on par with TLC NAND SSDs, and that is significantly higher than HDDs. In addition, Intel QLC 3D NAND SSDs allow for massive consolidation that accommodates scalability for future needs, while helping lower TCO today. Table 1 highlights the benefits of deploying an all-QLC NAND array over a hybrid array.

Table 1. Benefits of using an Intel SSD D5-P5316 over a common HDD for key CDN metrics.[3]

CDN metric	Hybrid TLC SSD + HDD array	All-QLC SSD array using Intel SSD D5-P5316	All-QLC SSD benefit
Server capacity	96TB	614TB	More than 6x better—scale to more content per server
Server throughput	51 Gbps	190 Gbps	More than 3.7x better—reach more users per server
Throughput per watt	0.046 Gbps/watt	0.17 Gbps/watt	More than 3.6x better—reduce operating costs

Replacing TLC NAND SSDs + HDDs with QLC NAND SSDs in mid-tier servers

Mid-tier servers have read-intensive workloads—typically up to 95 percent reads with sequential writes only occurring at low use periods. That makes QLC NAND SSDs a strong candidate to replace the hybrid arrays (TLC NAND SSD + HDD) commonly found in these servers. This is partly due to QLC NAND SSDs having TLC NAND SSD–equivalent read performance. But QLC NAND SSDs also have more than sufficient endurance for the job, when taking into account the large capacity of these drives compared to the limited write pressure of the workload. For example, a 30.72TB QLC NAND SSD x 0.41 drive writes per day (DWPD) x 365 days per year x 5 years equals 23 petabytes written (PBW).

Modeling a mid-tier installation requiring 480TB-per-node capacity and 190 Gbps-per-node throughput results in a nearly 5x consolidation of servers, with a TCO reduction of up to 42 percent, as shown in Figure 2.[4] In the original hybrid array, HDD storage needs to be significantly overprovisioned beyond capacity needs in order to meet throughput requirements. Replacing the overprovisioned array in this theoretical example with all QLC NAND SSDs reduces the number of servers from 331 to 67, leaving ample room for growth to scale with changing needs in content and users. Driving these impressive gains is the read-optimized performance of QLC NAND SSDs, which enables organizations to eliminate using TLC NAND SSDs as cache drives and replace HDDs with more space- and operationally-efficient capacity storage.

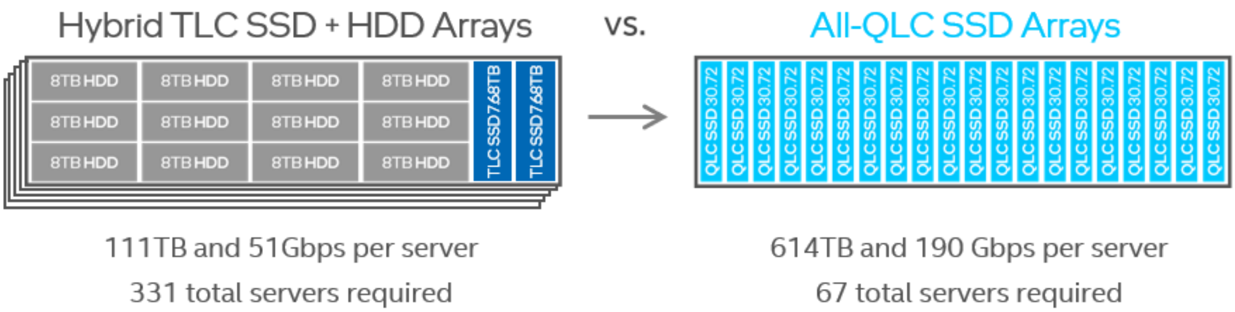

Figure 2. QLC NAND SSDs can replace hybrid storage arrays in mid-tier servers to provide significant storage and server consolidation.

Replacing Hybrid Array or all-TLC NAND with QLC NAND SSDs in edge servers

Edge servers have a similar workload profile to mid-tier servers, so they can also benefit from the read performance and capacity optimization of QLC NAND SSDs. One way to quantify these benefits is to model a server requiring 128TB capacity and 300 Gbps throughput under two different scenarios. Scenario 1 is ideal in emerging markets, where updating legacy hybrid array CDNs (TLC NAND SSD + HDD) to an all-QLC NAND SSD solution delivers up to 3.7x server consolidation and up to 2.8x TCO savings, with massively reduced OpEx benefits via footprint reduction, power and cooling efficiencies, and fewer drive replacements over time.[5] Scenario 2 targets a more typical all-TLC NAND SSD implementation, where choosing all-QLC NAND results in 22% greater server consolidation and up to 21 percent TCO savings, allowing providers to scale more efficiently while maintaining read-intensive content delivery SLAs.[6]

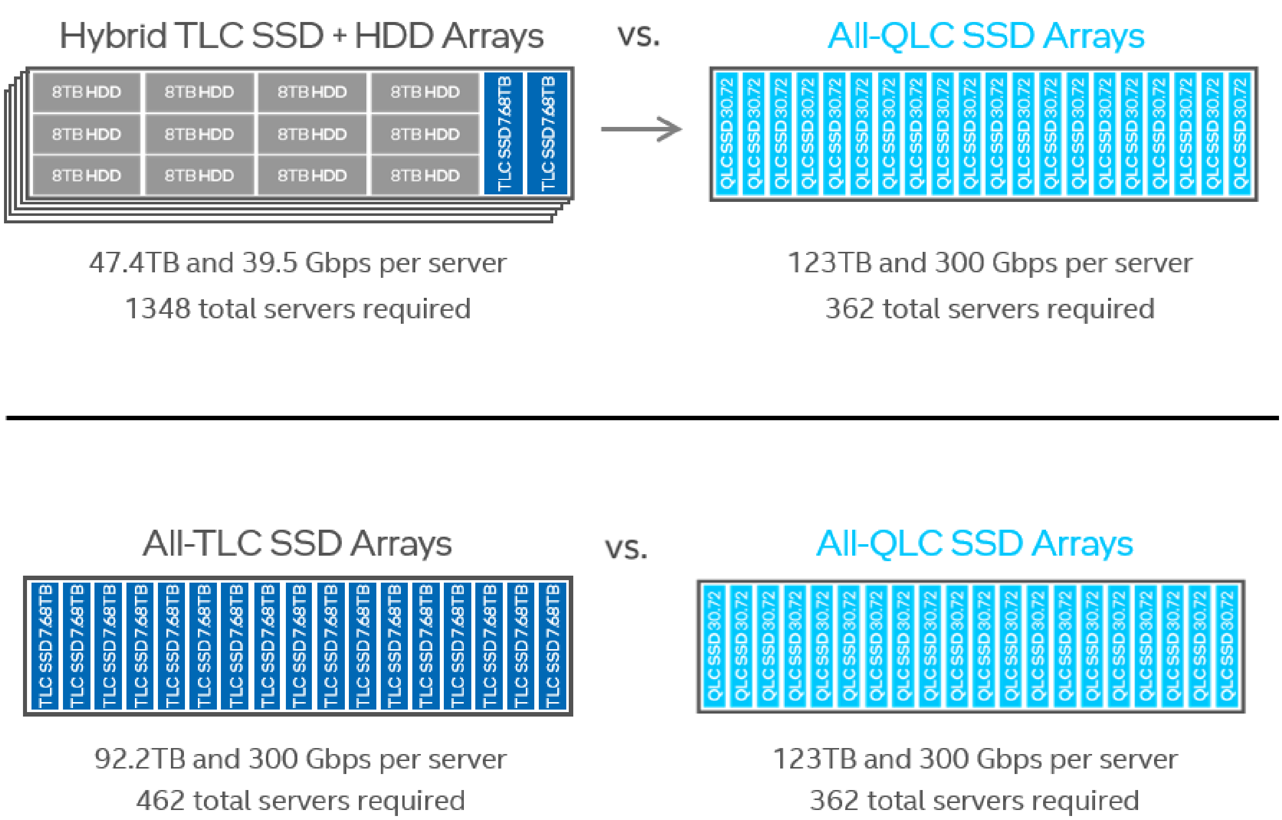

Figure 3. QLC NAND SSDs can replace hybrid or all-TLC NAND storage arrays in edge servers to provide significant storage and server consolidation.

Additional QLC NAND SSD benefits

In addition to the server TCO benefits noted above, QLC NAND SSD arrays at mid-tier and edge servers can benefit CDNs in other areas as well:

- Reduce downstream network traffic (return-to-source rate) through higher server bandwidth
- Economically scale to more content and more users with higher per-node capacity and bandwidth
- Improve first packet response times through low latency and high quality of service (QoS)

Modernizing storage to keep up with demand

VoD services are seeing explosive growth, putting pressure on service providers to meet that growth opportunity while maintaining service levels and improving efficiency to control costs.

Intel QLC 3D NAND SSDs offer an alternative to HDDs and TLC NAND SSDs for affordably modernizing storage to better support on-demand content delivery. With read performance equivalent to TLC NAND SSDs and much higher than HDDs, Intel QLC 3D NAND SSDs help storage architects reduce TCO, efficiently scale content, and expand content to more users.

Learn more

About Intel® 3D NAND SSDs

Intel® SSD D5-P5316 product brief

QLC NAND Technology Is Ready for Mainstream Use in the Data Center

QLC NAND SSDs Are Optimal for Modern Workloads

[1] Netflix. Shareholder letter. January 19, 2021. https://s22.q4cdn.com/959853165/files/doc_financials/2020/q4/FINAL-Q420-Shareholder-Letter.pdf.

[2] Fierce Video. "Hulu + Live TV loses 100,000 subscribers in Q4." February 2021. fiercevideo.com/video/hulu-live-tv-loses-100-000-subscribers-q4.

[3] Based on specifications for Intel SSD D5-P5316: intel.com/content/www/us/en/products/memory-storage/solid-state-drives/data-center-ssds/d5-series/d5-p5316-series.html, and Seagate Exos X18: seagate.com/files/www-content/datasheets/pdfs/exos-x18-channel-DS2045-1-2007GB-en_SG.pdf.

[4] Source for consolidating servers by nearly 5x and reducing TCO by up to 42 percent when upgrading from a hybrid TLC SSD and HDD array to an all-QLC SSD array:

Baseline server assumptions of 20K actives users, minimum capacity of 480TB, target throughput of 190 Gbps, and 85% cache hit ratio. Hybrid array per server configuration of 2 x Intel Xeon Scalable 6330 processors, 512GB memory, 12 x 8TB Seagate Exos HDD with 2.088 Gbps throughput, 2 x 7.68TB Intel SSD D7-P5510 with 56 Gbps throughput. Hybrid array cost (CPU + memory + RAID controller + NVMe expander + chassis + power supply) net of storage: $10,530. All-QLC per server configuration of 2 x Intel Xeon Scalable 6338N processors, 512GB memory, 20 x 30.72TB Intel SSD D5-P5316 with 54.4 Gbps throughput. All-QLC server cost (CPU + memory + RAID controller + NVMe expander + chassis + power supply) net of storage: $11,530. HDD pricing from-serversupply.com/HARD%20DRIVES/SATA-6GBPS/8TB-7200RPM/SEAGATE/ST8000NM000A_326073.htm, as of March 15, 2021. SSD pricing is Intel budgetary pricing. Actual price can vary and may not reflect the pricing used in the TCO model. Operating cost assumptions of 1,100watts/server $0.12/kWh power and cooling and $75.76 annual rack cost per RU.

[5] Source for 3.7x server consolidation and up to 2.8x TCO savings when upgrading from a hybrid TLC SSD and HDD array to an all-QLC SSD array:

Baseline server assumptions of 20K active users, minimum capacity of 128TB, target throughput of 300 Gbps, and 85% cache hit ratio. Hybrid array per server configuration of 2x Intel Xeon Scalable 6330 processors, 512GB memory, 12x 8TB Seagate Exos HDD with 2.088 Gbps, 2x 7.68TB Intel SSD D7-P5510 with 56 Gbps throughput. Hybrid array cost (CPU + memory + RAID controller + NVMe expander + chassis + power supply) net of storage: $11,930. All-QLC per server configuration of 2x Intel Xeon Scalable 6338N processors, 512GB memory, 16x 30.72TB Intel SSD D5-P5316 with 54.4 Gbps throughput. All-QLC server cost (CPU + memory + RAID controller + NVMe expander + chassis + power supply) net of storage: $12,930. HDD pricing from serversupply.com/HARD%20DRIVES/SATA-6GBPS/8TB-7200RPM/SEAGATE/ST8000NM000A_326073.htm, as of March 15, 2021. SSD pricing is Intel budgetary pricing. Actual price can vary and may not reflect the pricing used in the TCO model. Operating cost assumptions of 1,100watts/server, $0.12/kWh power and cooling, and $75.76 annual rack cost per RU.

[6] Source for 22% server consolidation and up to 21% TCO savings when comparing an all-TLC SSD array to an all-QLC SSD array:

Baseline server assumptions of 20K active users, minimum capacity of 128TB, target throughput of 300 Gbps, and 85% cache hit ratio. Hybrid array per server configuration of 2x Intel Xeon Scalable 6330 processors, 512GB memory, 20x 7.68TB Intel SSD D7-P5510 with 56 Gbps throughput. Hybrid array cost (CPU + memory + RAID controller + NVMe expander + chassis + power supply) net of storage: $12,930. All-QLC per server configuration of 2x Intel Xeon Scalable 6338N processors, 512GB memory, 16x 30.72TB Intel SSD D5-P5316 with 54.4 Gbps throughput. All-QLC server cost (CPU + memory + RAID controller + NVMe expander + chassis + power supply) net of storage: $12,930. SSD pricing is Intel budgetary pricing. Actual price can vary and may not reflect the pricing used in the TCO model. Operating cost assumptions of 1,100watts/server, $0.12/kWh power and cooling, and $75.76 annual rack cost per RU.

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