MSSQL with NVDIMMs

TPCH Performance with QLC and NVDIMMs

Micron Storage Solutions Engineering

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Quick Stats

Micron by the Numbers

Headquarters
Boise, Idaho, USA

Age
40 years strong

Size
3rd largest memory company in the world

Market Position
4th largest semiconductor company

Fortune 500
Ranked #150 in 2017

FY18 Net Sales
$30.4B

Team Members
34,000+ in 17 countries

Locations
12 manufacturing sites

Patents
~40,000 and growing

Products
Largest portfolio of memory and storage technologies

Segments
Compute, consumer, networking, storage, embedded and mobile products

September 2017, Source: Micron and industry analysts

Using QLC SATA SSDs in Enterprise Storage

7 trends

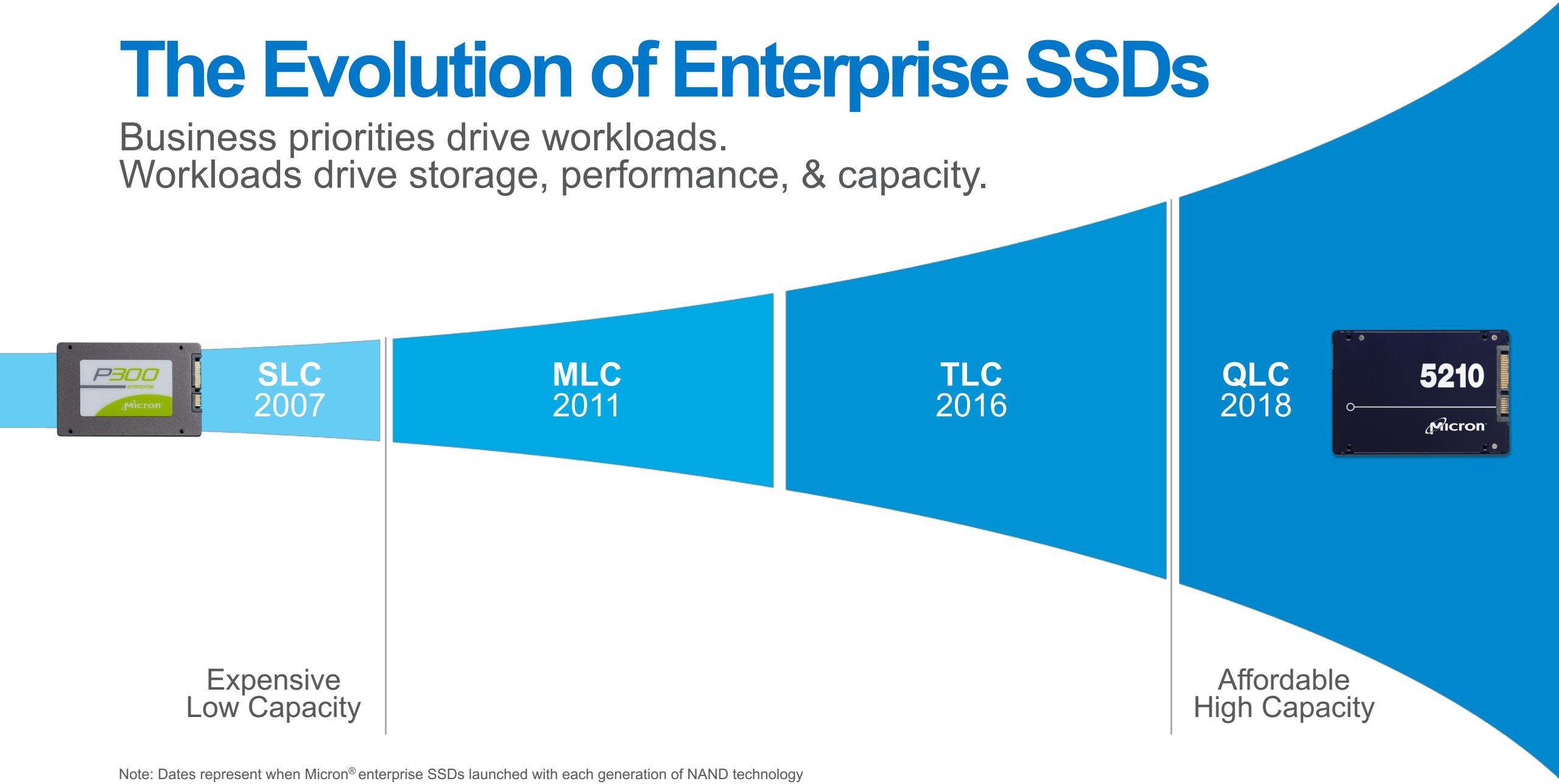
1. Movement from SAN/NAS to direct-attached storage
2. Massive data growth: world projected to hit 163ZB by 2025
3. Fast flash brings new connection points between HCI & edge computing
4. Billions of data entries every day are feeding AI, ML, DL
5. SSD capacity per server increasing rapidly due to SDS
6. System architecture moving toward distributed infrastructure
7. New architectures needed to support real-time analytics

The vast majority of all data needs to be read and analyzed quickly.

Not rewritten repeatedly.

The Evolution of Enterprise SSDs

Business priorities drive workloads.
Workloads drive storage, performance, & capacity.



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

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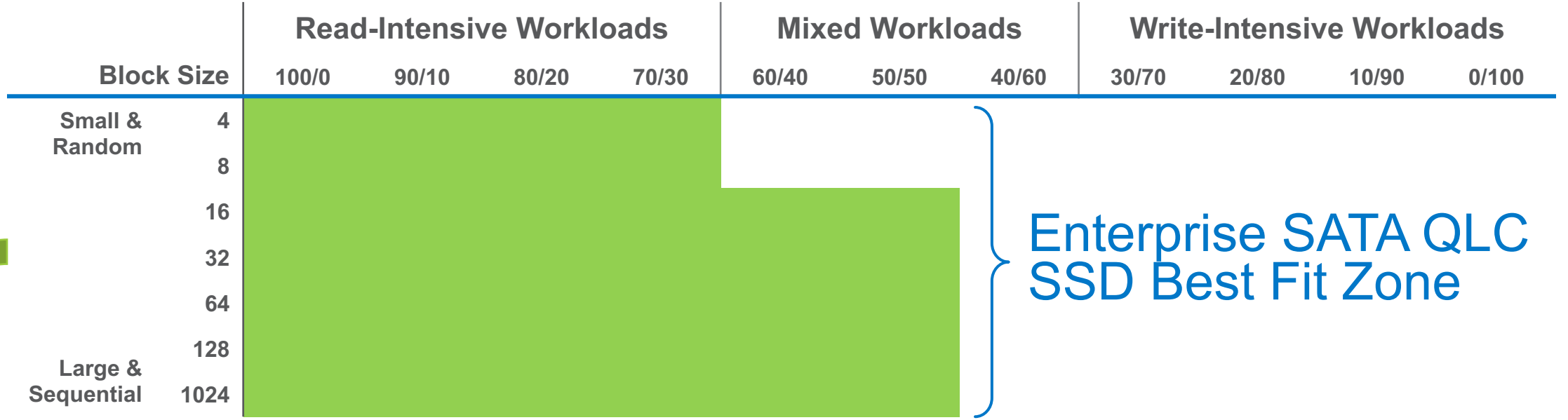
The Many Best-Fit Workloads for QLC

Ask customers: “What are your top 3 workload priorities?”

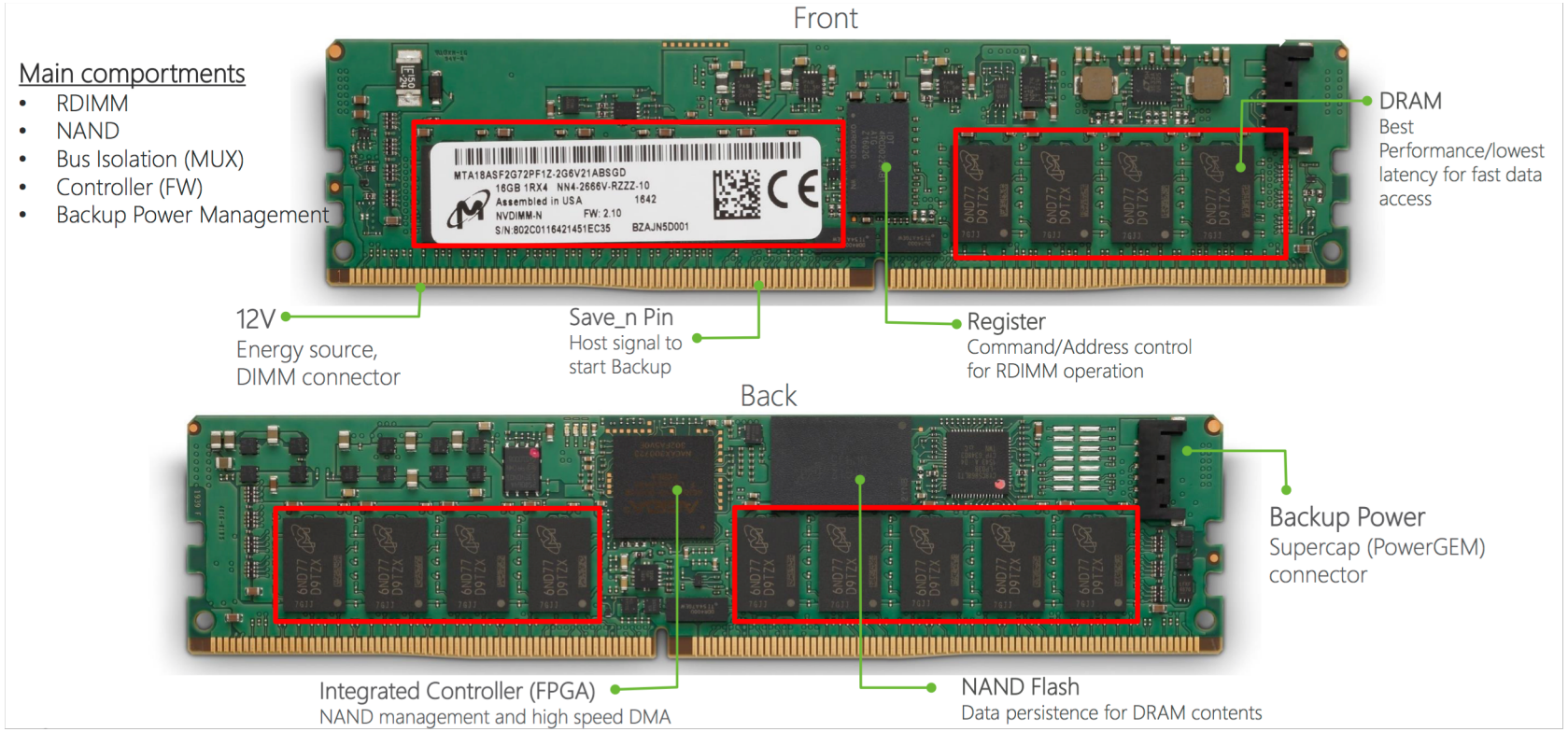


The Many Workloads in this Zone:	**Read-Intensive AI** Data Lakes	**Machine & Deep Learning** Data Lakes	**Real-Time Analytics & Big Data** Hadoop HDFS	**Ceph** Large Block & Object Stores	**SQL** Business Intelligence	**NoSQL** Mongo DB, Cassandra	**Media Streaming** CDNs
CY’17-21 CAGRs*	43%	13%	42%	36%	9%	20%	14%

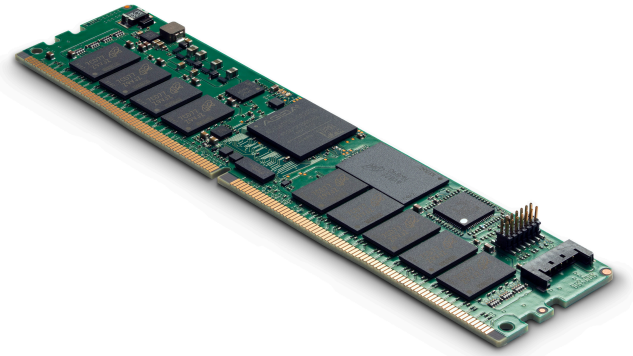
*Based on industry analysis from IDC, Gartner, Statista, Forbes

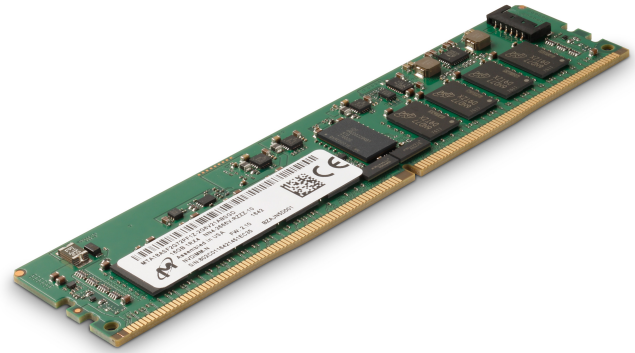
The Impact of NVDIMM-N

NVDIMM Anatomy



Micron Persistent Memory (NVDIMM-N)



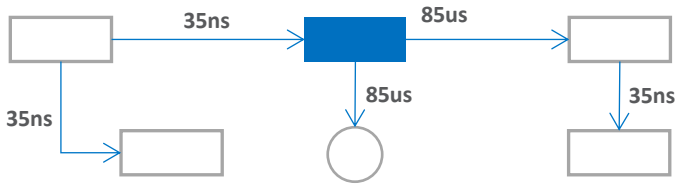


32GB NVDIMM-N
- RDIMM Operation
- 2933 MT/s
- Backup power (Tethered or DIMM connector)
- Available NOW

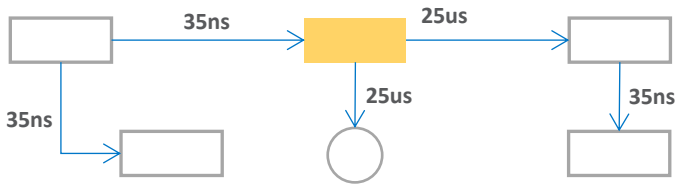
16GB NVDIMM-N
- RDIMM Operation
- 2933 MT/s
- Backup power (Tethered or DIMM connector)
- Available NOW

Impact of NVDIMM-N on Application Performance

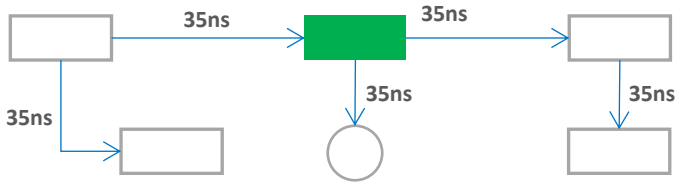
DRAM + NAND-Based NVMe SSD)

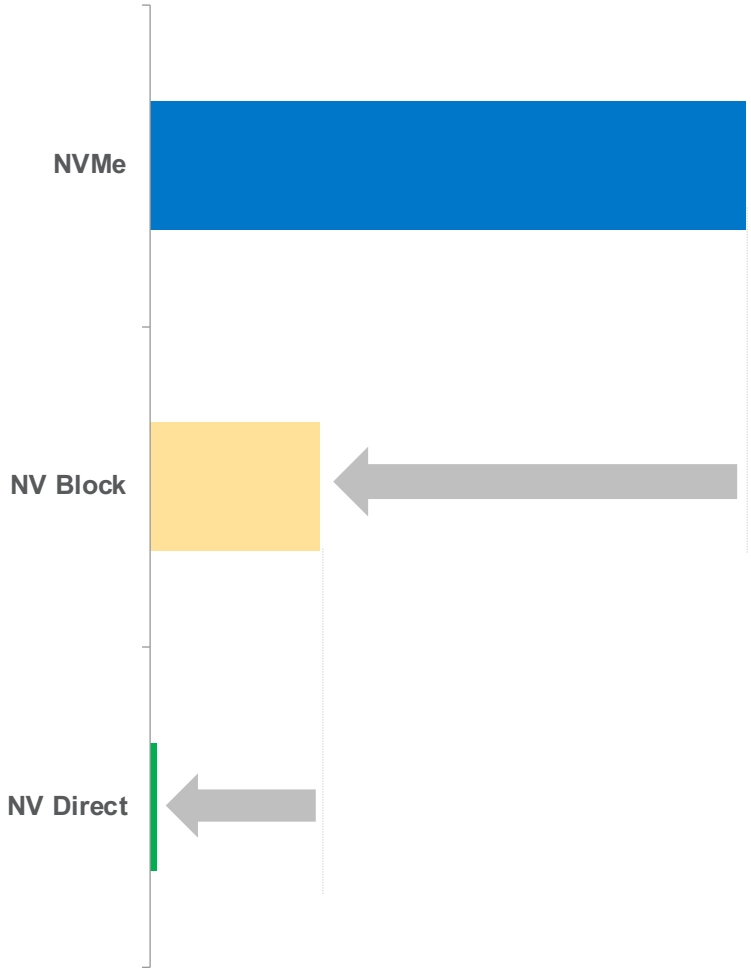


DRAM + NVDIMM-N Block Mode



DRAM + NVDIMM-N Direct Mode





- Data committed to persistent media written to ***NAND*** through the I/O stack

- Data committed to persistent media written to ***DRAM*** on NVDIMM-N through the I/O stack
- Latency improvement due to writing to DRAM (35ns) versus NAND (85,000ns)

- Data committed to persistent media written to ***DRAM*** on NVDIMM-N through Load/Store Bus
- Latency improvement due to circumventing overhead associated with I/O stack

MSSQL with NVDIMMs

TPCH Performance with QLC and NVDIMMs

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Test System Overview

Dell EMC R740XD

- 2 socket, 48 core, 96 threads
- 384 GB RAM
- Dell HBA 330
- Windows Server 2016
- SQL Server Enterprise 2017

TPCH on MSSQL

Testing Overview

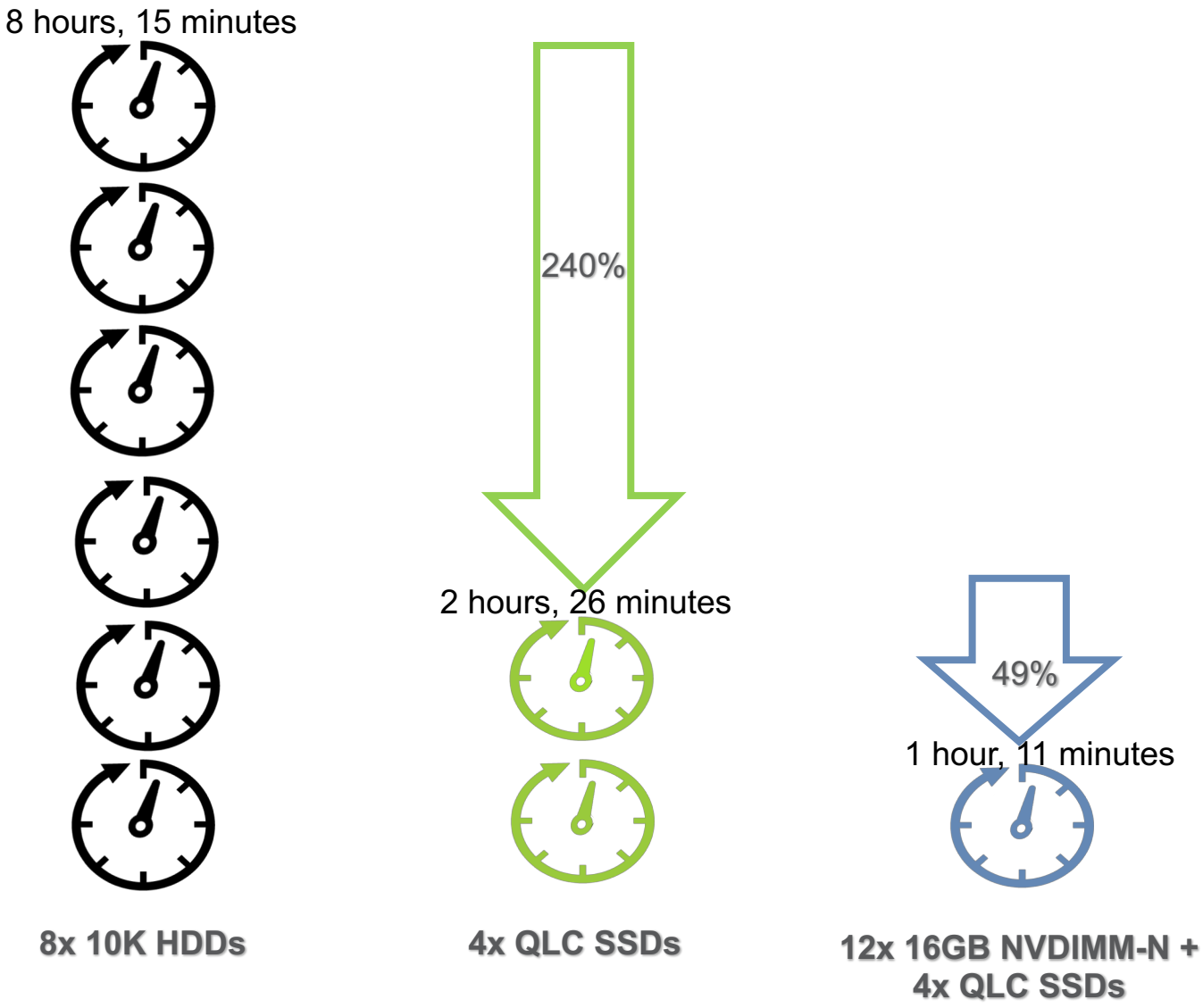
- The results were obtained by running an OLAP workload based on the TPC-H specification and using automation built around TPC QGEN.
- Configurations
  - **8x 2.4TB Enterprise Hybrid 10K HDD**
  - **4x 7.68TB 5210 ION QLC SSD**
  - **12x 16GB NVDIMM-N + 4x 7.68TB 5210 ION QLC SSD**
    - TempDB is placed on the NVDIMMs
- Each configuration was tested with a single stream of MAX DOP.
- 3000 scale factor TPC-H dataset
  - ~6TB with column store indexes
- Executed single sequence of 22 queries

Key Metrics

- **Run Time**
  - Time to complete a single TPC-H query sequence
- **Disk Throughput**
  - Raw drive performance independent of application metrics
- **Energy Consumption**
  - Metric to evaluate system TCO

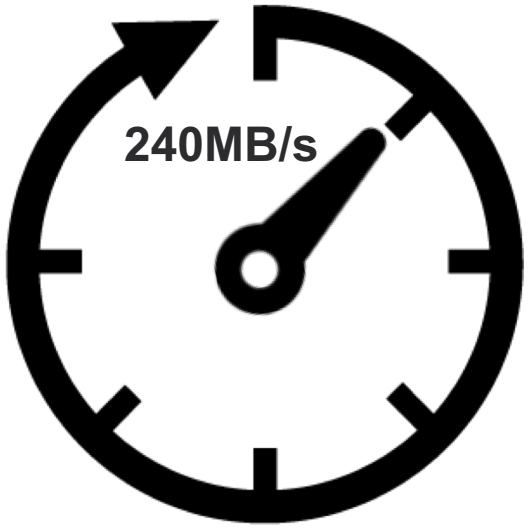
Stream Run Time (Lower the better)

TPC-H



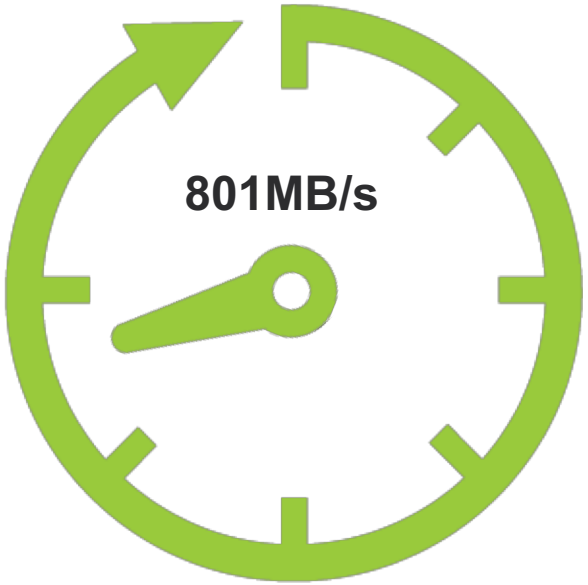
Disk Throughput by Configuration

TPC-H



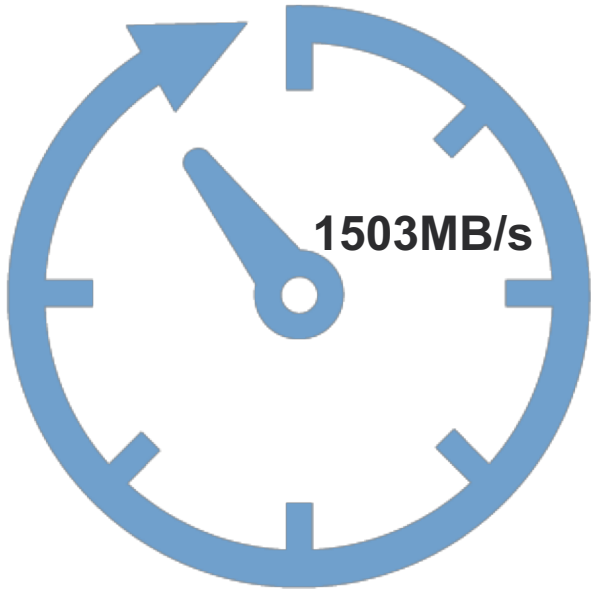
8x 10K HDDs

3x



4x 5210 ION

6.2x



12x NVDIMM +
4x 5210 ION

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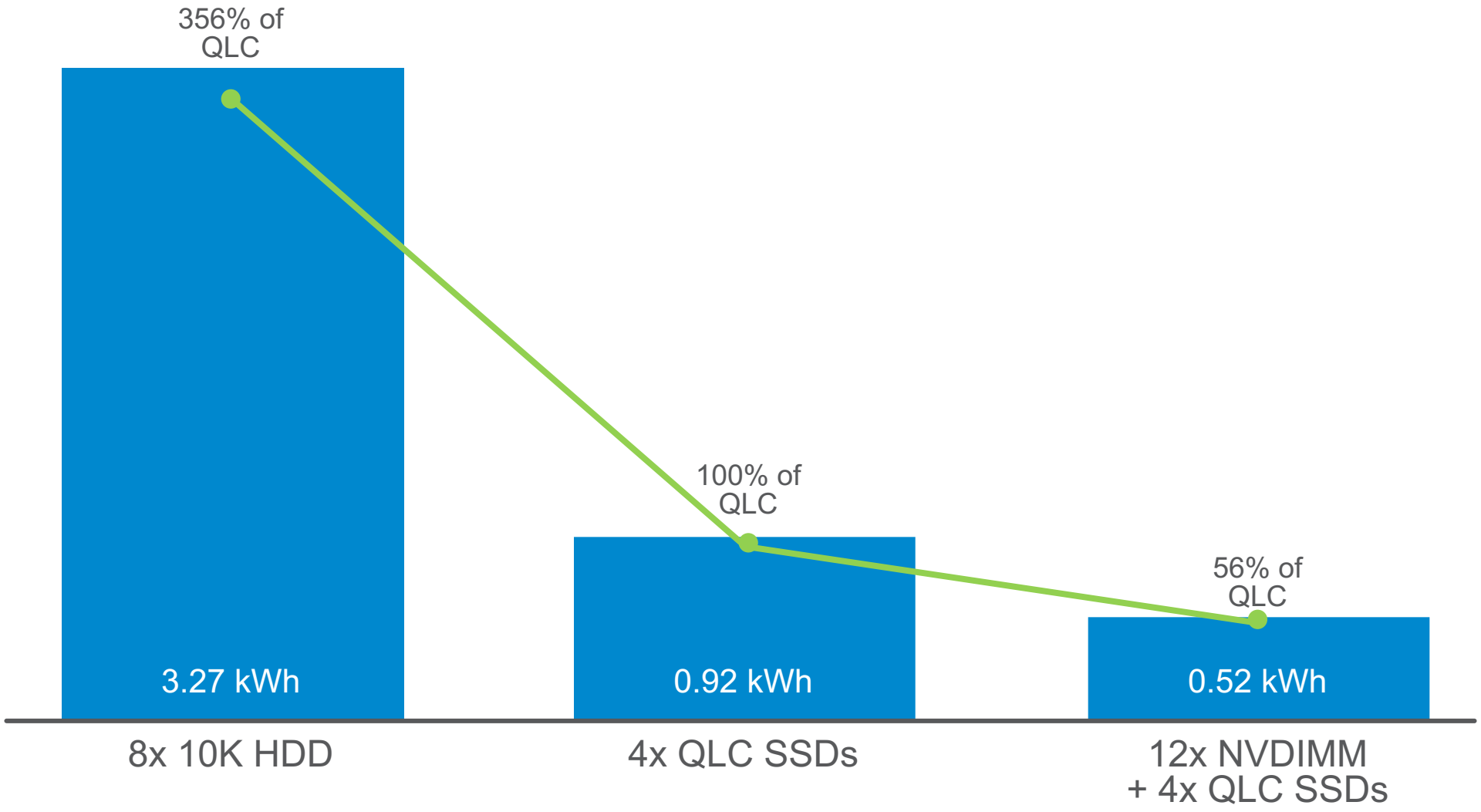
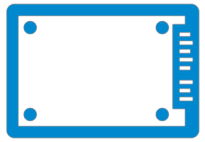
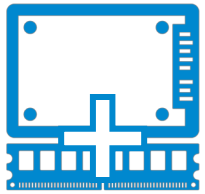
Energy Consumption in Kilowatt Hours (kWh)



Takeaways



QLC alone increased performance by **240%** when compared to HDD



Adding NVDIMMs further increased performance by **~50%**

Guaranteed endurance with TempDB moved to NVDIMMs

Energy consumption improves with each configuration

- QLC consumes 1/3 the energy of HDD
- Adding NVDIMMs further reduces energy consumption by ~50%

Additional collateral:

- We're Flexing Our Quads: Introducing the World's First QLC solid state drive.
- Getting more performance with Micron® 5210 ION SSDs and a BI/DSS workload on Microsoft® SQL Server: platform tuning and tempdb placement
- Get Even More out of your QLC for SQL Server
- Feel Free to reach out:

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