

**Western Digital®**

# **Big Data, Fast Data – Making The Right Choice**

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*Global Sr. Director*

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**Flash Memory Summit**

# Forward-Looking Statements

## *Safe Harbor | Disclaimers*

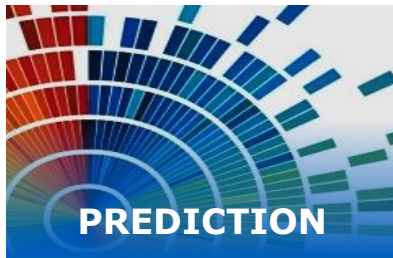
This presentation contains forward-looking statements that involve risks and uncertainties, including, but not limited to, statements regarding our data center products and technologies, expectations regarding data usage and storage, our business strategy, growth opportunities, and demand and market trends. Forward-looking statements should not be read as a guarantee of future performance or results, and will not necessarily be accurate indications of the times at, or by, which such performance or results will be achieved, if at all. Forward-looking statements are subject to risks and uncertainties that could cause actual performance or results to differ materially from those expressed in or suggested by the forward-looking statements.

Key risks and uncertainties include volatility in global economic conditions, business conditions and growth in the storage ecosystem, impact of competitive products and pricing, market acceptance and cost of commodity materials and specialized product components, actions by competitors, unexpected advances in competing technologies, difficulties or delays in manufacturing, and other risks and uncertainties listed in the company's filings with the Securities and Exchange Commission (the "SEC") and available on the SEC's website at [www.sec.gov](http://www.sec.gov), including our most recently filed periodic report, to which your attention is directed. We do not undertake any obligation to publicly update or revise any forward-looking statement, whether as a result of new information, future developments or otherwise, except as required by law.

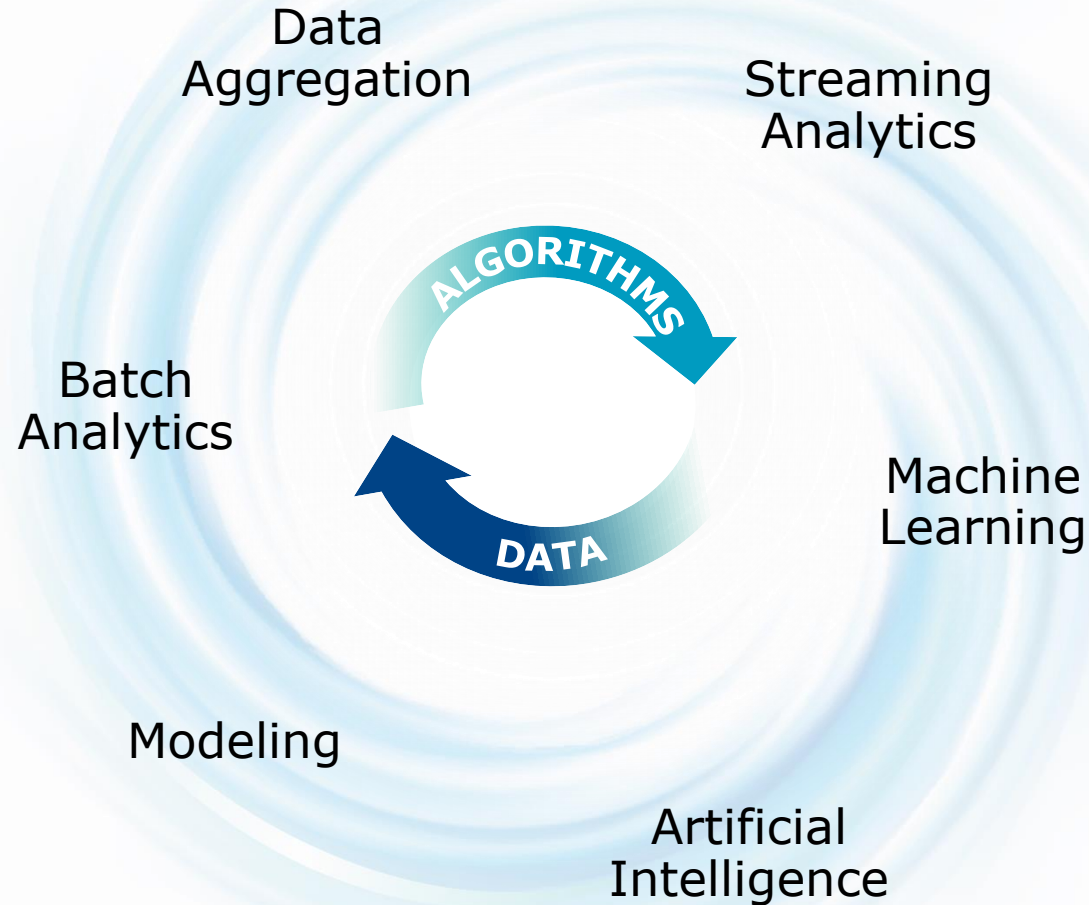
# Diverse and Connected Data Types

*Tight coupling between Big Data and Fast Data*

## Big Data



## Scale

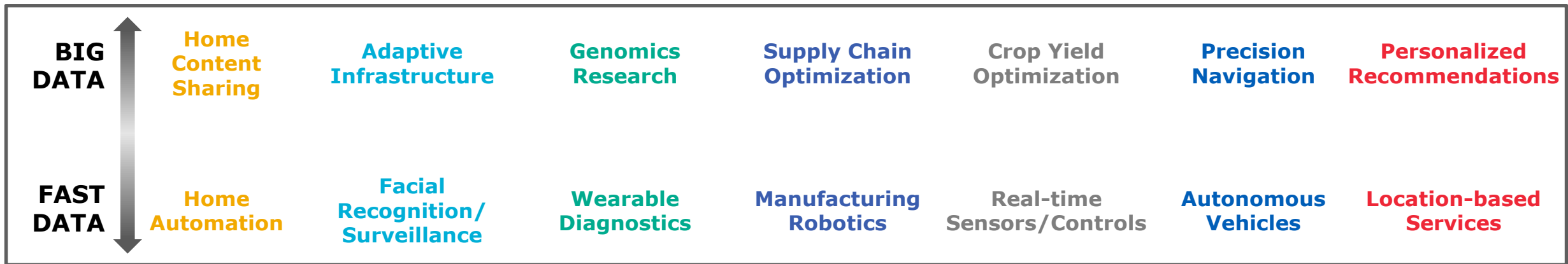


## Fast Data



## Performance

# Data Transforming Industries



# Western Digital®

## Use Case by Deployment



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# Big Data

- Microsoft Certified Microsoft® SQL Server® Data Warehouse Fast Track Reference Architecture on SAS SSDs
- Provides excellent best balance of storage economics per bit and performance without overwhelming CPU or network.

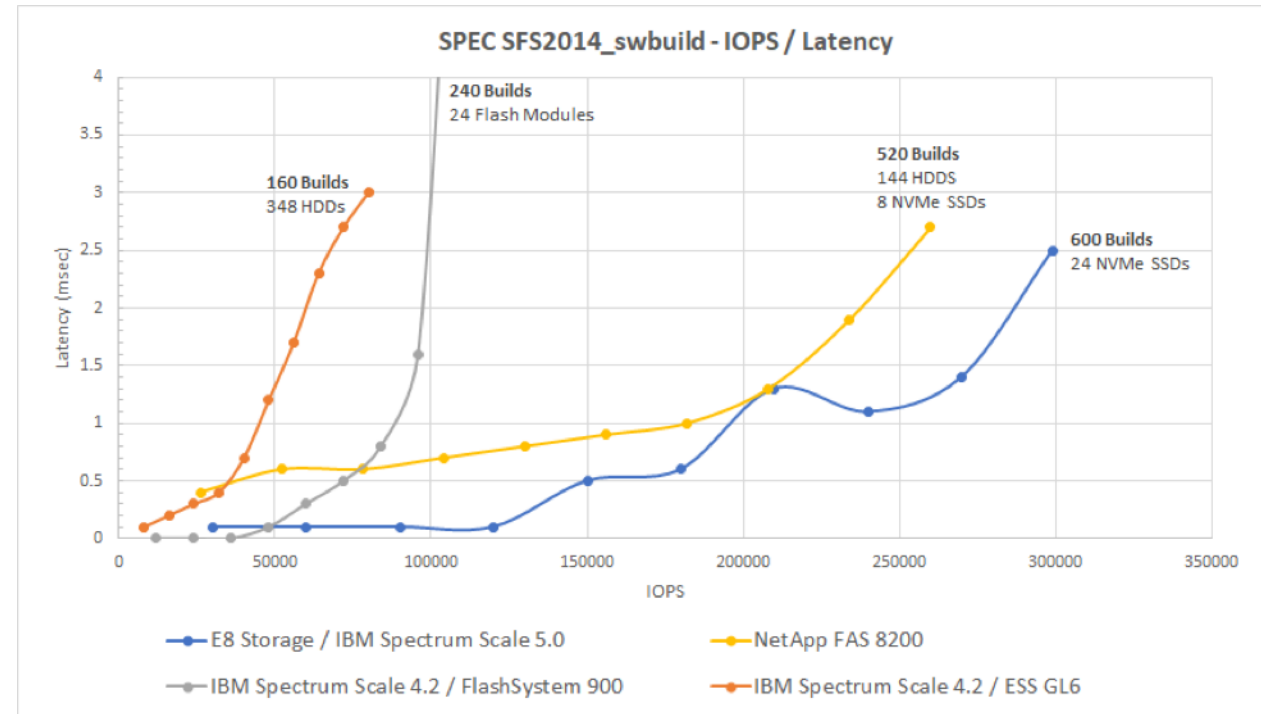
Peak Throughput	Measure I/O Throughput	Average CPU Utilization%	Average Read Latency	Queries/Hr/TB	Max User Data Capacity
42GB/s	20GB/s	95%	500 µsec	5850	219TB

“HPE ProLiant DL580 Gen10 with the Ultrastar SS300 SSD delivers industry-leading performance with the ability to host vast data warehouses or consolidate data warehouses.

SQL Server Data Warehouse Fast Track record-breaking rated user data capacity of 195TB.”

# Fast Data – File System

- NVMe helps E8 Storage Break SPEC SFS® Performance Record – Files System Acceleration SPEC SFS®2014
- Workload is similar to media/entertainment (rendering, CGI), life sciences (genomic sequencing), as well as financial markets (real-time analytics, statistics).
- Record breaking performance achieved using 24 Ultrastar SN200 NVMe SSDs in their E8-D24 storage appliance.



- More builds – over 2.5x more than the previous IBM Spectrum Scale test
- More performance – Almost 300,000 file system operations per second
- Lowest latency – a record breaking 0.69ms!

# Fast Data - OLAP

- Ultrastar® SN200 NVMe™ SSDs Help Cisco Achieve Their Highest TPC-H Score
- Benchmark Overview
  - TPC-H is a database benchmark test with wide industry support.
  - Composite Score reflects capability of the system to process complex queries.
  - In partnership with Cisco and Microsoft, plan to announce a new high score for Cisco on the 3TB TPC-H Benchmark

- Solution Highlights

- Performance

- 1,000,000+ TPC-H Composite Score!
    - 22GB/s Peak Throughput
    - > 95% average CPU utilization
    - 1ms average latency

- **Approximately 14% cost savings over previous Cisco 3TB TPC-H world record**

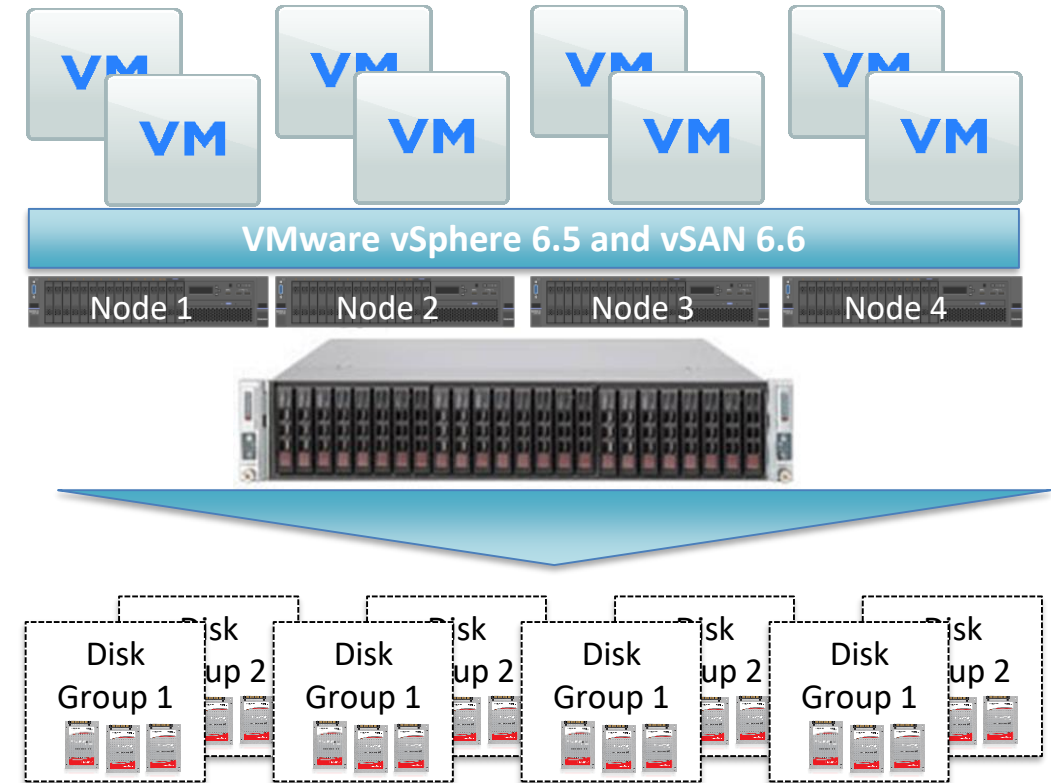


Cisco C240-M5 Rack Server  
4 x 3200GB Ultrastar SN200 Series PCIe SSDs



# Big & Fast Data - Hyper-Converged

- Integrated hyper-converged solution with Essential NVMe SSDs
- Certified VMware vSAN Ready Node
- Joint solution brochure and TCO White paper to outline the benefits of NVMe
- Performance characterization for key vSAN workloads by Western Digital



Hyperconverged solutions running VMware vSAN accounted for 33.3% of the market share making VMware the largest HCI software vendor in the market – *Source IDC Q22017 Worldwide Quarterly Converged System Tracker*

# What's Next for Device Technology

*Vertical Innovation improves supply chain economics*

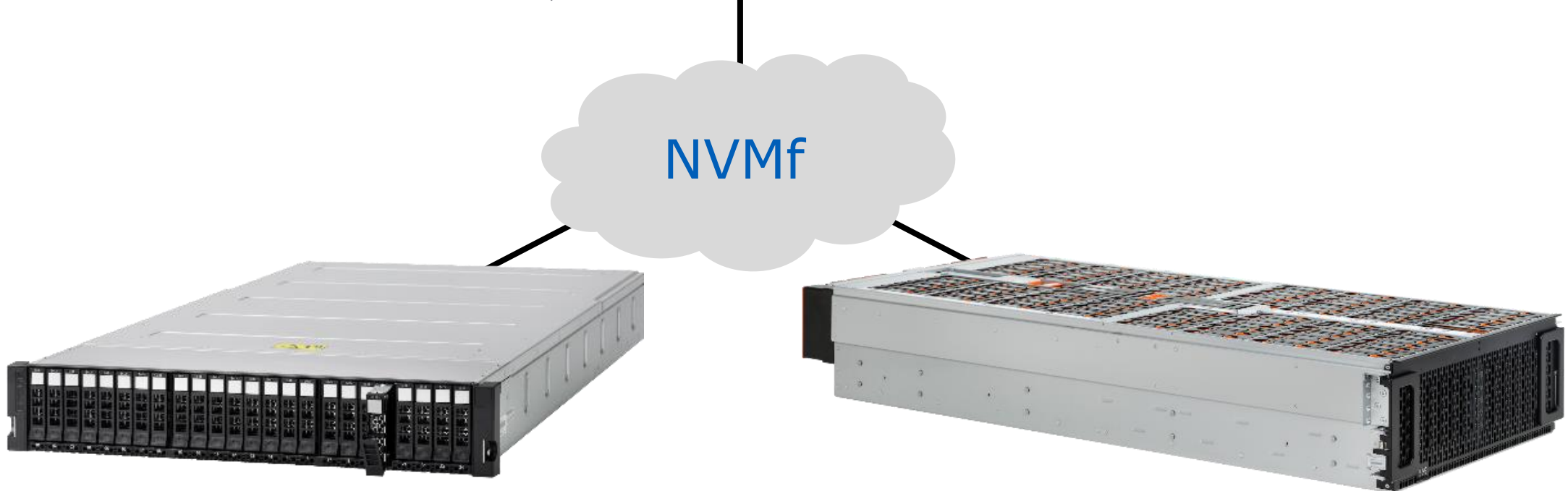
## Dense Enclosures

- SSD & HDD on NVMf
- Unify flash & disk on one protocol
- New standards & APIs
- Ecosystem maturity



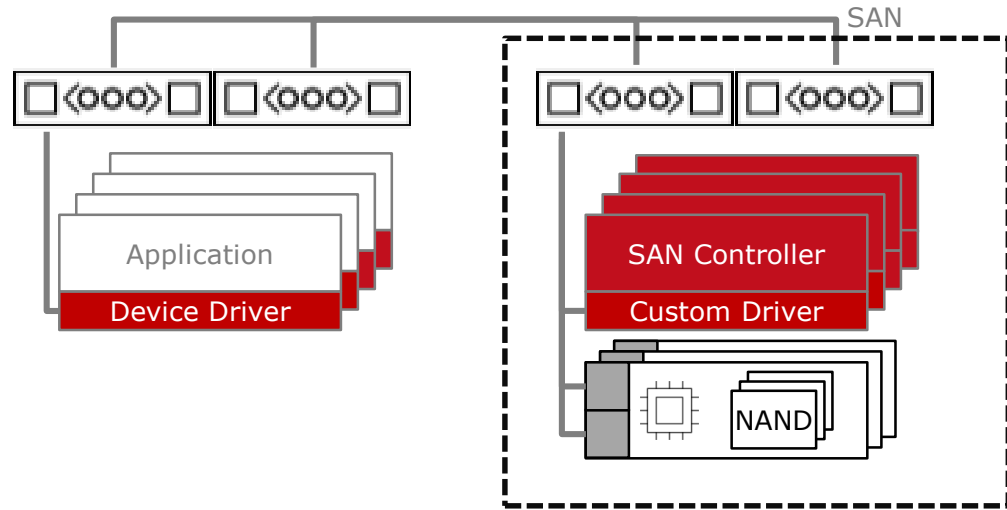
## Benefits

- Storage not tied to a server
- Access from anywhere
- Independently scale storage and compute

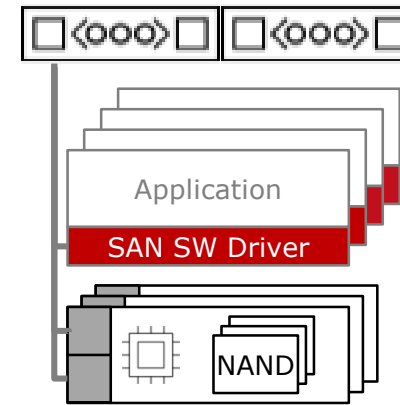


# Use Models

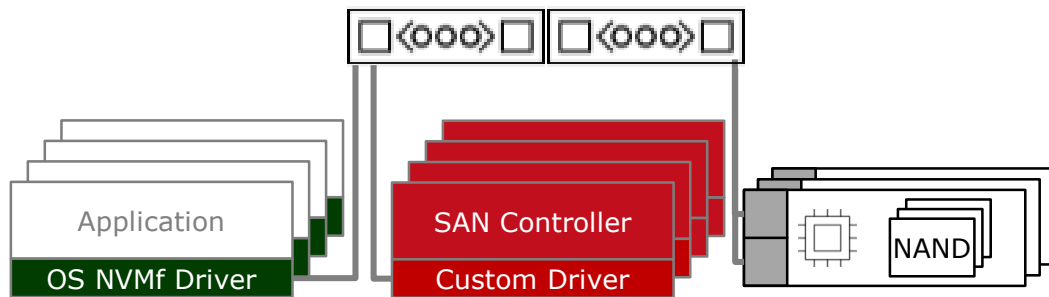
(1) Traditional SAN Appliance



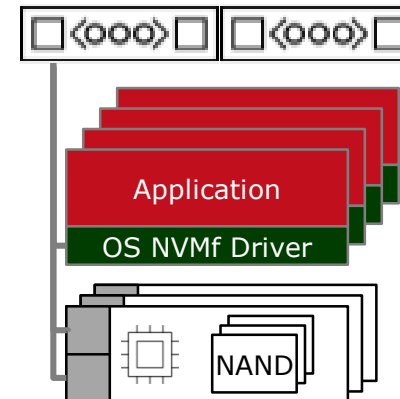
(3) Distributed SW SAN



(2) Distributed HW SAN

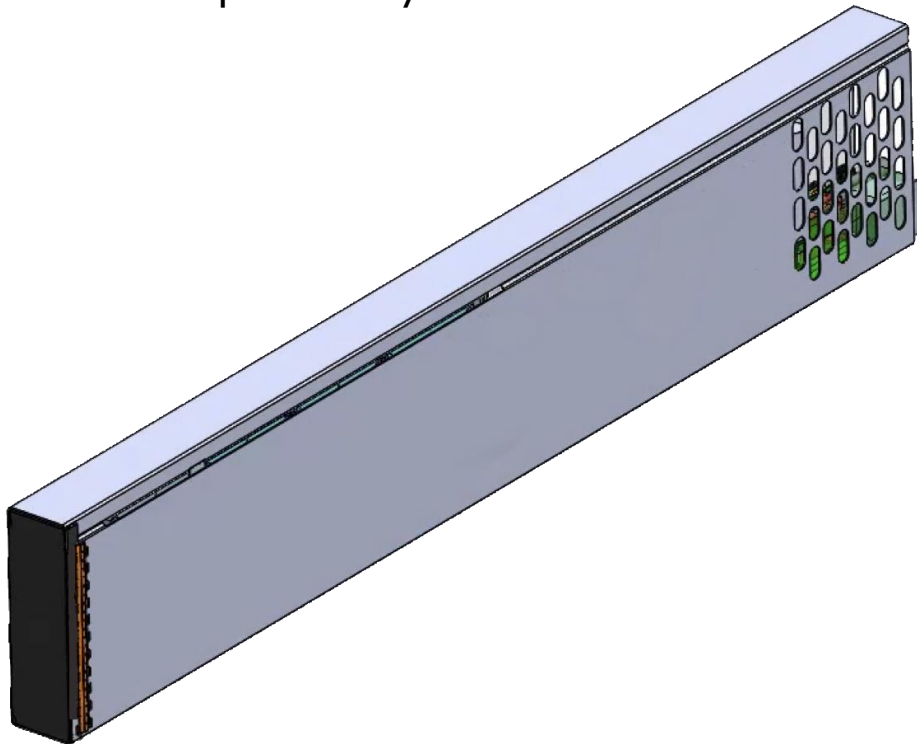


(4) Application Managed



# NVMeoF Flash Drive

- Maintains existing device model
  - Dual-port SSD
  - Dual QSFP28 network ports per drive
  - Fabric provides multi-path resiliency
  - Power loss protection
  - Simpler building block
  - PCIe replaced by Ethernet



		OpenFlex™ F3000				
<b>Protocol</b>	Ethernet					
<b>Ports</b>	Dual QSFP28 (2x50Gb)					
<b>Performance</b>	12GB/s – 2.5M 4K IOPS					
<b>Power</b>	200 W					
<b>Endurance</b>	1 DWPD			3 DWPD		
<b>Capacity (TB)</b>	15.3	30.7	61.4	12.8	25.6	51.2

# NVMf Disk Device

- Network Addressable Drive
  - Behaves like a single large HDD
  - Presents NVMf Namespaces
  - 25Gb performance matched to bandwidth of 12 HDDs
  - Has QoS policies not possible on a single dual-port SAS HDD
- SMR Abstraction
  - Makes SMR HDD look like PMR
  - Fast write IOPS received into local M.2 flash
  - Sequentialize all writes to improve performance

	OpenFlex™ D3000	
Protocol	Ethernet	
Ports	Dual SFP28 (2x25Gb)	
Performance	3GB/s – ~2,000 4K IOPS	
Power	200 W	
Mode	CMR	SMR
Capacity (TB)	168	192



# Data Interaction – Enabling the future state

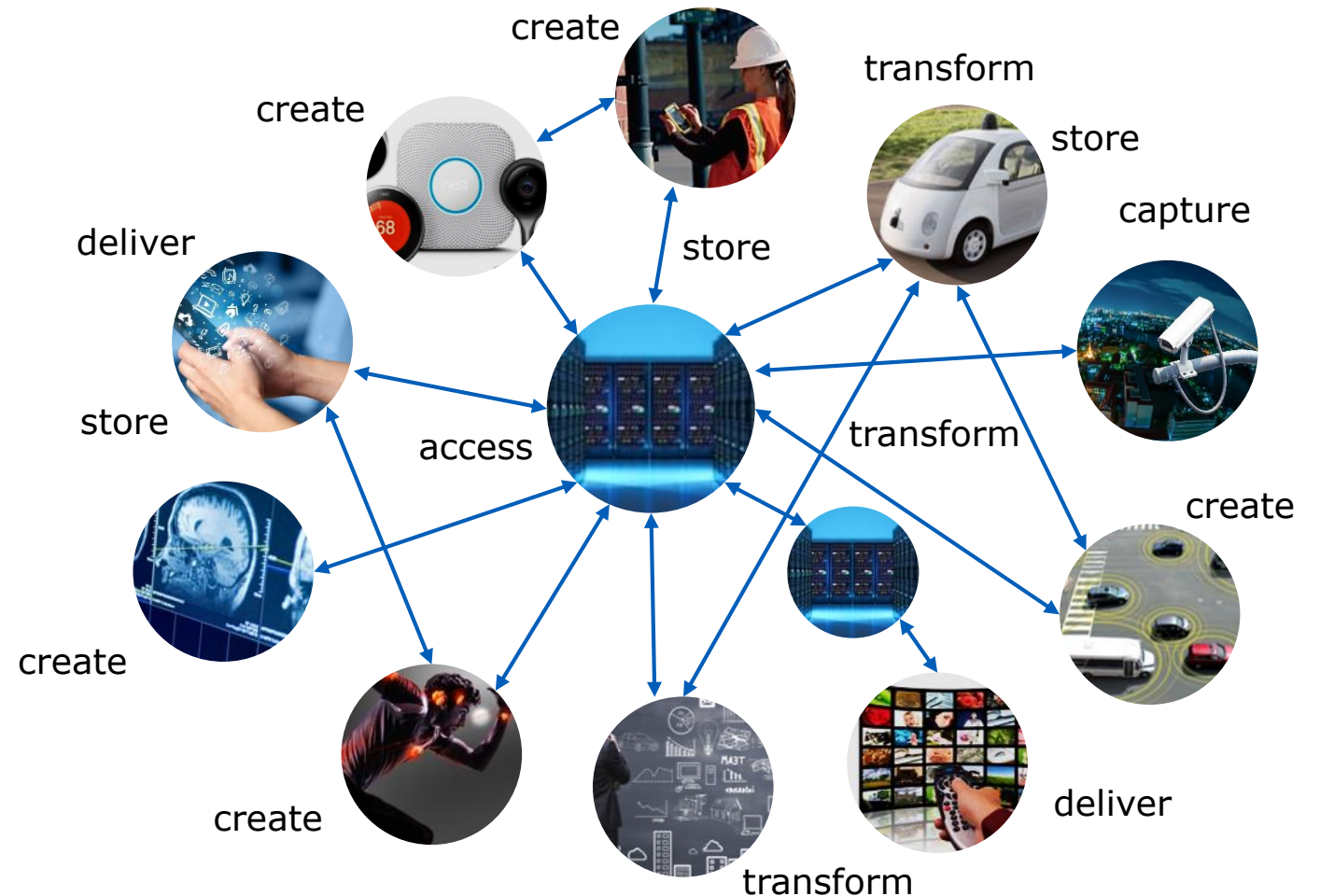
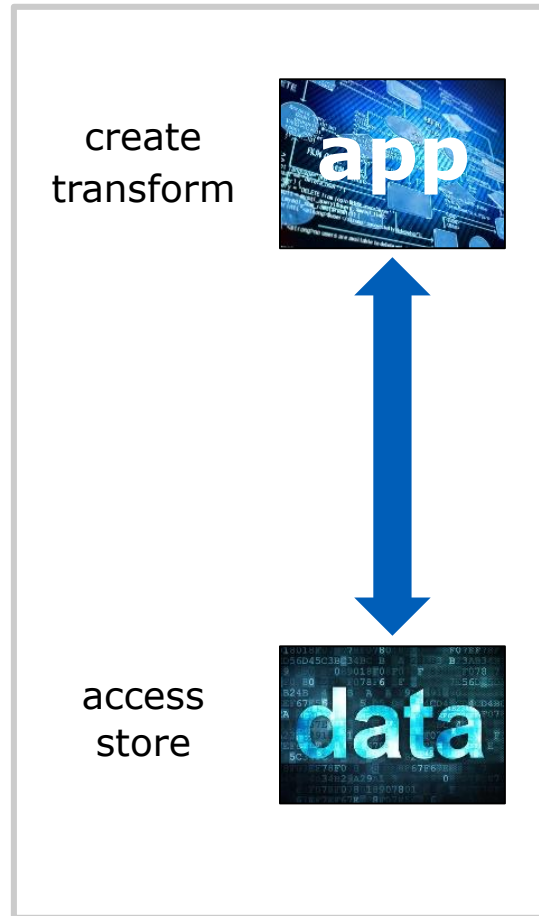
**From This**



**To This**

Data Held Captive by Single Application

Data Pooled and Shared by Multiple Applications



The image features the Western Digital logo in a large, white, sans-serif font, centered horizontally. The background is a dark, abstract composition of numerous thin, overlapping lines in shades of orange, red, and purple, creating a sense of motion and depth. The lines are most concentrated on the right side of the image, where they appear to radiate outwards.

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