Big Data, Fast Data – Making The Right Choice

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Global Sr. Director
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Forward-Looking Statements

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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, 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

- Data Aggregation
- Batch Analytics
- Modeling
- Artificial Intelligence
- Machine Learning

Fast Data

- Streaming Analytics

Scale

- INSIGHT
- PREDICTION
- PRESCRIPTION

Performance

- SMART MACHINES
- MOBILITY
- REAL-TIME RESULTS

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Data Transforming Industries

BIG DATA
- Home Content Sharing
- Adaptive Infrastructure
- Genomics Research
- Supply Chain Optimization
- Crop Yield Optimization
- Precision Navigation
- Personalized Recommendations

FAST DATA
- Home Automation
- Facial Recognition/Surveillance
- Wearable Diagnostics
- Manufacturing Robotics
- Real-time Sensors/Controls
- Autonomous Vehicles
- Location-based Services
Use Case by Deployment
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.

<table>
<thead>
<tr>
<th>Peak Throughput</th>
<th>Measure I/O Throughput</th>
<th>Average CPU Utilization%</th>
<th>Average Read Latency</th>
<th>Queries/Hr/TB</th>
<th>Max User Data Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>42GB/s</td>
<td>20GB/s</td>
<td>95%</td>
<td>500 μsec</td>
<td>5850</td>
<td>219TB</td>
</tr>
</tbody>
</table>

“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
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 Q2 2017 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

(2) Distributed HW SAN

(3) Distributed SW SAN

(4) Application Managed

Where storage services are implemented
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

<table>
<thead>
<tr>
<th>OpenFlex™ F3000</th>
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<tbody>
<tr>
<td><strong>Protocol</strong></td>
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<tr>
<td><strong>Ports</strong></td>
</tr>
<tr>
<td><strong>Performance</strong></td>
</tr>
<tr>
<td><strong>Power</strong></td>
</tr>
<tr>
<td><strong>Endurance</strong></td>
</tr>
<tr>
<td><strong>Capacity (TB)</strong></td>
</tr>
</tbody>
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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

<table>
<thead>
<tr>
<th>OpenFlex™ D3000</th>
<th>Protocol</th>
<th>Ethernet</th>
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</thead>
<tbody>
<tr>
<td>Ports</td>
<td>Dual SFP28 (2x25Gb)</td>
<td></td>
</tr>
<tr>
<td>Performance</td>
<td>3GB/s – ~2,000 4K IOPS</td>
<td></td>
</tr>
<tr>
<td>Power</td>
<td>200 W</td>
<td></td>
</tr>
<tr>
<td>Mode</td>
<td>CMR</td>
<td>SMR</td>
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<tr>
<td>Capacity (TB)</td>
<td>168</td>
<td>192</td>
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Data Interaction – Enabling the future state

From This
Data Held Captive by Single Application

To This
Data Pooled and Shared by Multiple Applications

create
transform
access
store

app
data