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EXTRAORDINARY NEW DEMANDS FACE THE DATA CENTER
A VARIETY OF REQUIREMENTS ACROSS APPS

PRIVATE

- Biz critical apps
- Sufficient IT scale
- Large datasets
- Predictable capacity
- Data Sovereignty
- Privacy, security

HYBRID

PUBLIC

- Start-ups
- Insufficient IT scale
- New apps
- Undifferentiating apps
- Unpredictable demand

- Large datasets
- Sufficient IT scale
- Predictable capacity
- Data Sovereignty
- Privacy, security

LARGE DATASETS

UNPREDICTABLE DEMAND

DIFFERENTIATING APPS

UNPREDICTABLE DEMAND

INSUFFICIENT IT SCALE

DATA SOVEREIGNTY

PRIVACY, SECURITY

BIZ CRITICAL APPS

SUFFICIENT IT SCALE

PREDICTABLE CAPACITY

LARGE DATASETS

DIFFERENTIATING APPS

UNPREDICTABLE DEMAND

INSUFFICIENT IT SCALE

DATA SOVEREIGNTY

PRIVACY, SECURITY

BIZ CRITICAL APPS
Storage and Data Across Infrastructures

**TRADITIONAL STORAGE**

**CHALLENGE**

Seamlessly access data anywhere, at anytime, on any device, at the required performance

**CLOUD STORAGE**
THE STORAGE MODERNIZATION JOURNEY

Modernize
- Storage Intelligence
  - Thin-provisioning
  - De-duplication
  - Compression
  - Encryption
  - Multi-tenancy
- Hard Drive to Solid State Drive
  - SSD Moore’s Law
  - Storage Intelligence
  - Performance
  - Emergence of new storage arrays:
    - All Flash
    - Hybrid

Automate
- Architecture & Workload
- Unifying Cloud & Enterprise
  - Scale Up Architecture
  - Scale Out Architecture
  - Hyperconverged
  - Software Defined Storage
    - Orchestrated management
    - Service Level Agreements

Orchestrate
- Seamless integration across architecture, media and vendors
  - Network Function Virtualization
  - Software Defined Infrastructure
  - Shift of the IO bottleneck
  - Business alignment

Storage Modernization enhances existing and new environments enabling seamless data services in the datacenter
INTEL ENABLING STORAGE MODERNIZATION
CREATING SEAMLESS DATA SERVICES IN THE DATA CENTER

Server Based Storage Architectures
Media Transition
Software Defined
What is NVMe Express Over Fabrics?

- Industry standard definition of NVMe over Data Center Fabrics
- Shares the same base Architecture and NVMe Host Software as PCIe
- Enables NVMe scale-out and low latency operations on Data Center Fabrics

NVMe over Fabrics is the most efficient Block Interface on Data Center Fabrics
NVME OVER FABRICS STANDARDIZATION AND ENABLING

- Industry-wide NVMexpress.org TWG community defined NVMe Fabrics
  - Dozens of companies participated in the definition over last ~18 months
- NVMe Over Fabrics Specifications were released on June 6th 2016
  - Downloadable from www.nvmexpress.org/specifications
- Linux Kernel Host and Target Drivers available
  - www.nvmexpress.org/drivers
  - Integrated and tested with Linux 4.7-RC1 Kernel, plan is to upstream with 4.8 Kernel
- Intel SPDK User-Level NVMe over Fabrics Target
  - Downloadable from https://github.com/spdk
Commonality Between NVMe on PCIe and Fabrics

The vast majority of NVMe is leveraged as-is for Fabrics

- NVMe host interface, NVM Subsystem, Controllers, Namespaces, Commands, Registers/Properties, Power States, Asynchronous Events, Reservations, etc.
- Allows for use of common NVMe Host software with very thin fabric dependent layers

Primary differences reside in the discovery and queuing mechanisms

<table>
<thead>
<tr>
<th>Differences</th>
<th>PCI Express® (PCIe)</th>
<th>Fabrics</th>
</tr>
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<tr>
<td>Identifier</td>
<td>Bus/Device/Function</td>
<td>NVMe Qualified Name (NQN)</td>
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<tr>
<td>Discovery</td>
<td>Bus Enumeration</td>
<td>Discovery and Connect commands</td>
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<tr>
<td>Queuing</td>
<td>Memory-based</td>
<td>Message-based</td>
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<tr>
<td>Data Transfers</td>
<td>PRPs or SGLs</td>
<td>SGLs only, added Key</td>
</tr>
</tbody>
</table>
Fabric Capsules are messages with “encapsulated” common NVMe content.

Data Section may be sent within the Capsule (as shown) or via a fabric type dependent data transfer mechanism, example RDMA_READ/RDMA_WRITE.
NVMe OVER FABRICS CAPSULE EXCHANGE EXAMPLE

Host

NVMe Host Software Driver

Send NVMe CMD Capsule

RCV NVMe RSP Capsule

Fabric Dependent Transport

Port

NVM Subsystem

NVMe Controller

RCV NVMe CMD Capsule

SND NVMe RSP Capsule

Fabric Dependent Transport

Port

Submission Queue Entry

 Completion Queue Entry

NVMe CMD Capsule

NVMe RSP Capsule
Create a fabric-dependent transport connection

Send a Command Capsule with Fabric Connect Operation (AdminQ Connect establishes an “association” to an NVMe Controller)

<opt> Send Authentication Fabric Commands

AdminQ or IOQ Ready for NVMe Commands
SOME OF THE USE CASES FOR NVME OVER FABRICS

Hyperconverged Cloud

Disaggregated Cloud

External Storage
NVME OVER FABRICS CLOUD STORAGE TAXONOMY

Disaggregated Compute Node

NVMe Software

Scalable fabric Interconnect

Disaggregated NVMe Storage Node

Compute Optimized Enclosures

Ethernet with RDMA

Scale-Out Compute + NVMe SSD

NVMe PCIe SSD Capacity and Caching Optimized Enclosures

Compute Scaling

Enables independent scaling of compute and NVMe SSD enclosures

NVMe Over Fabrics (Ethernet/RDMA)

Capacity Optimized

Caching Optimized
Disaggregated NVMe over Fabrics Enclosure Options

Intel Processor Based
• NVMe Target S/W (Front-End)
• SPDK or Linux Target S/W
• Typically have storage abstractions
  • Endurance, Security, High Avail.
    (RAID, Compute fail-over, …)

NVMe Bridge Based
• Bridges NVMe to PCIe NVMe
• Discrete or integrated into RNIC
• High IOPS/Low Power
• JBOD like functionality with limited SSD sharing capabilities
• PCIe SSD sharing features will help
  • Multiple namespaces, SR_IOV, CRB, ROC, …
Cloud Storage Usage

Model (Disaggregated OSD block-store)

- Ceph OSD Software runs on disaggregated compute nodes (2 Socket Intel® Xeon™ E5)
- NVMe software enables access to disaggregated NVMe SSDs
- Capacity and Performance optimized NVMe SSD enclosures
ENABLE SEAMLESS DATA SERVICES ACROSS CLOUDS

Seamless Data Services: Agile, Automated, and Secure

Unified, Comprehensive Services Management & Orchestration – IaaS to SaaS
THE FUTURE OF STORAGE STARTS HERE

ACCELERATE THE PACE OF CHANGE

OPTIMIZE STORAGE SOLUTIONS WITH BUILDERS LABS

ENABLE SEAMLESS DATA SERVICES ACROSS CLOUDS AND TO THE EDGES
INTEL
EXPERIENCE NEXT GENERATION STORAGE

INVEST
in accelerating next generation storage solutions

EMBRACE
Intel® Solid State Drive & Intel® Optane technology for high performance

ALIGN
to accelerate software-defined storage
Join us for a mixer to enjoy an evening full of networking and to leverage business opportunities.

INTEL® STORAGE BUILDERS NETWORKING RECEPTION

BAYSHORE ROOM SECOND FLOOR, SEPTEMBER 21ST 6:00-8:00 PM