NVMe Over Fabrics
Real World Use Cases and Applications

August 11, 2015

Idan Burstein
Storage Architect, Mellanox Technologies
History – Directly Attached to Shared

- Major advantages for sharing
  - High availability
  - Utilization and provisioning
    - Deduplication, compression
    - Thin provisioning
- Cost
- Historically disks were slow
  - Storage software stack was built for hard disks, very slow relatively to memory
  - Storage network was fast relative to disks, very slow relatively to memory
Evolution of Disk Arrays

**Disk SAN**
- Memory was used for caching
- Slow disks

**Disk SAN with Local NVMe**
- Storage network has become too slow
- Flash prices dropped
- NVMe
- Demand for cache intensive latency sensitive tasks
- NVMe devices used for caching
- Convergence to fast RDMA fabrics

**Disk and Flash SAN Local Memory-Like NVM**
- Demand for consistent performance from array
- HDD-like Flash disaggregation
- All flash arrays used for fast storage (caching)
- JBOD are used for cold storage

<1usec latency
Flash Array Use Case

- **Benefits of NVMe over Fabrics for disaggregation**
  - **Scale of RDMA**
    - Scaling out with RDMA networks, beyond PCIe scaling limitations
  - **Performance of RDMA**
    - Low latency, high bandwidth, parallel interface, locally attached like performance for accessing the devices
  - **Minimal CPU utilization at the subsystem and the host**
    - Lockless parallel design from client to disk
    - Reduction of protocol translation
    - Reduction of the CPU overhead of large data transfers through RDMA
  - **Convergence**
    - Compute and storage in the same network

- **Why is it good for backend?**
  - Scaling number of disks independent of the compute
  - Low latency, high bandwidth shared access
    - For example to enable HA and deduplication algorithms
  - Lower CPU%
    - Frontend servers - more CPU% for smart storage algorithms
    - Subsystem servers - enable low cost solutions

- **Why is it good for frontend?**
  - Lower CPU%
    - Frontend servers - More CPU% for smart storage algorithms
    - Client servers – Data is moved without CPU → more compute resources → $
History – Directly Attached to Shared

- Advantages for sharing
  - Management and failover
    - Thin provisioning
    - High availability
    - Utilization
  - Deduplication, compression
- Storage network was fast relative to disks, very slow relatively to memory
- Storage software stack was built for hard disks
Hyper-Converged Use Case

- Storage is distributed across the compute nodes and shared among the nodes
- Storage management and provisioning is software defined and distributed
- Benefits of NVMe over Fabrics
  - The most important: major reduction in CPU utilization while sharing devices, the compute nodes are not disrupted by storage → more compute resources for applications
  - Locally attached like performance
  - Scaling of RDMA network
  - Converged network
    - No protocol translation and no additional dedicated hardware
NBDx – NVMe over Fabrics POC

- Open source
- RDMA enabled
- Multi-Queued
  - From submission to completion, all on same core, initiator and target
- End-to-end lock free
- No protocol translations
- Userspace only demo – FIO
  - Engine that opens QPs, CQs and speaks NBDX

**Performance results:**
- 2us added latency for WRITEs
- 5us added latency for READs

https://github.com/accelio/NBDX
Future

Locally Attached

JBOD

Locally Attached

Network Connected Drive

Locally Attached

Locally Attached NVMe

NVMe over Fabrics JBOF/AFA

NVMe

NVMe over Fabrics Connected Drives

NVMe

Locally Attached Future Memory-Like NVM

Just a Bunch of Future Memory-Like NVM

Future Memory-Like NVM

Requires very fast network and new programming model

Requires tight integration of RDMA and NVMe