NVMe Over Fabrics: Scaling Up With The Storage Performance Development Kit

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Agenda

- Design Overview
- Benchmarking
  - Connections
  - CPU cores
Design Overview
NVMe-oF Primitives

- `spdk_nvmf_tgt`
- `spdk_nvmf_subsystem`
- `spdk_nvmf_transport`
Subsystems are **global**

- Subsystems have states
  - Inactive
  - Paused
  - Active

- `spdk_nvmf_subsystem` may only be modified while not in the active state.
- Contains controllers and namespaces
NVMe-oF Primitives

- spdk_nvmf_poll_group
  - spdk_nvmf_subsystem_poll_group
  - spdk_nvmf_transport_poll_group

Per-thread Scope
- Per-thread collection of transport data
- Uses a transport-specific mechanism to efficiently poll the group
  - RDMA: Shared completion queue
  - FC: Shared hardware queue pair
  - TCP: epoll/kqueue
- The queue pairs are not necessarily related to one another
• Per-thread collection of subsystem data
  ▪ Contains thread-unique I/O channels for each namespace in the subsystem.
  ▪ Think of an I/O channel as an NVMe queue pair for the local device.
Accepting a New Connection

- spdk_nvms_tgt_accept()
- new_qpair_fn(qpair)
- spdk_nvms_poll_group_add(qpair)

When does a queue pair identify which subsystem it belongs to?
Performing an I/O

- No Locks!
- Touches only thread-local data (cache friendly)!
- Lookups are all array math!

Poll group checks for incoming requests associated with a subsystem and targets a namespace in subsystem poll group. Look up I/O channel for subsystem + namespace in subsystem poll group. Use I/O channel to submit I/O to bdev layer.
Benchmarks
Scaling: Active Connections

Single Core

Number of Active Connections (Queue Depth 32)

4K Reads Per Second

System Configuration: 2x Intel® Xeon® Platinum 8180 CPU @ 2.50 GHz, Intel® Speed Step enabled, Intel® Turbo Boost Technology enabled, 4x 2GB DDR4 2666 MT/s, 1 DIMM per channel, Ubuntu* Linux 17.10, Linux kernel 4.13.0, SPDK 18.04, DPDK 18.01, Mellanox® ConnectX-4 MT27700
Scaling: Idle Connections

Number of Idle Connections

4K Reads Per Second

 Millions

0 0.2 0.4 0.6 0.8 1 1.2 1.4

0 1 16 128 512

Single Core

System Configuration: 2x Intel® Xeon® Platinum 8180 CPU @ 2.50 GHz, Intel® Speed Step enabled, Intel® Turbo Boost Technology enabled, 4x 2GB DDR4 2666 MT/s, 1 DIMM per channel, Ubuntu* Linux 17.10, Linux kernel 4.13.0, SPDK 18.04, DPDK 18.01, Mellanox® ConnectX-4 MT27700
Performance vs Number of CPU Cores

4K Read I/O Per Second

Number of CPU Cores (Target)

System Configuration: 2x Intel® Xeon® Platinum 8180 CPU @ 2.50 GHz, Intel® Speed Step enabled, Intel® Turbo Boost Technology enabled, 4x 2GB DDR4 2666 MT/s, 1 DIMM per channel, Ubuntu® Linux 17.10, Linux kernel 4.13.0, SPDK 18.04, DPDK 18.01, Mellanox® ConnectX-4 MT27700
Thank You