THE STORAGE PERFORMANCE DEVELOPMENT KIT AND NVME-OF

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Storage Performance Development Kit

• What is SPDK?
• The SPDK Community
• Why are so many storage companies using it?
• How is it being used?
WHAT IS SPDK?
WHAT IS SPDK?

**Scalable and Efficient Software Ingredients**

- User space, lockless, polled-mode components
- Up to millions of IOPS per core
- Designed to extract maximum performance from non-volatile media

**Storage Reference Architecture**

- Optimized for latest generation CPUs and SSDs
- Open source composable building blocks (BSD licensed)

http://SPDK.IO
SPDK ARCHITECTURE

Storage Protocols
- NVMe-oF* Target
- iSCSI Target
- vhost-scsi Target
- vhost-blk Target
- Linux nbd
- NVMe
- SCSI

Storage Services
- Block Device Abstraction (bdev)
  - 3rd Party
  - Logical Volumes
  - GPT
- NVMe
- Linux AIO
- Ceph RBD
- PMDK blk
- virtio scsi

Drivers
- NVMe Devices
  - NVMe-oF Initiator
  - NVMe PCIe Driver

Integration
- Cinder
- RocksDB
- Ceph
- QEMU

Core
- Application Framework

17.03 Release
Added since 17.03
1H’18
THE SPDK COMMUNITY
THE SPDK COMMUNITY
Full Transparency

http://SPDK.IO
Main Web Presence

Email Discussions

Weekly Calls
Multiple Annual Meetups

Real Time Chat w/
Development Community

Backlog and
Ideas for Things to Do

GerritHub™
GitHub
Code Reviews & Repo

Jenkins
Continuous Integration

OpenFabrics Alliance Workshop 2018
WHY ARE SO MANY STORAGE COMPANIES USING SPDK?
SOFTWARE IS BECOMING THE BOTTLENECK

Latency

- HDD: >2ms
- SATA NAND SSD: <100μs, >25,000 IO/s
- NVMe® NAND SSD: >400,000 IO/s
- Intel® Optane™ SSD: >500,000 IO/s

I/O Performance

- <500 IO/s

SPDK Unlocks New Media Potential
SPDK BENEFITS

Storage Performance Development Kit

- Up to **10X MORE** IOPS/core for NVMe-oF* vs kernel
- Up to **8X MORE** IOPS/core for NVMe vs kernel
- Up to **50% BETTER** tail latency w/RocksDB workloads
- **FASTER TTM** w/less RESOURCES vs from scratch
- Provides **FUTURE PROOFING** as technologies evolve

Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more information go to [http://www.intel.com/performance](http://www.intel.com/performance)
INDUSTRY INVOLVEMENT

And many more!
HOW IS SPDK BEING USED?
APPLICATION ACCELERATION
(LOCAL STORAGE)

- Provides direct access from application to media
- BDEV abstraction provides consistent API to various types of block devices
- Benefits: dramatically reduces latency and improves IO consistency
REMOTE ACCESS TO STORAGE

- NVMe-oF supports different fabrics:
  - RDMA (iWARP, RoCE)
  - InfiniBand™
  - Fibre Channel
  - Intel® Omni-Path Architecture
  - TCP (coming soon)

- Unified interface for the NVMe PCIe driver and the NVMe-oF initiator

- Libraries & applications
ISCSI TARGET ACCESS

As Ceph performance matures, enable higher efficiency access

Potential for innovation in data services (e.g. cache, dedup...)
VIRTUAL MACHINE ACCELERATION

- Provides dynamic block provisioning
- Increases VM density
- Decreases guest latency
- Works with KVM/QEMU
 Blobstore enables SSD virtualization
 BDEV enables stackable SW
 BDEV enables innovation
NVME-OF
A WORD ON THE SPDK NVME DRIVER

SPDK reduces NVMe software overhead up to 10x!

<table>
<thead>
<tr>
<th>Kernel Source of Overhead</th>
<th>SPDK Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interrupts</td>
<td>Asynchronous Polled Mode</td>
</tr>
<tr>
<td>Synchronization</td>
<td>Lockless</td>
</tr>
<tr>
<td>System Calls</td>
<td>User Space Hardware Access</td>
</tr>
<tr>
<td>DMA Mapping</td>
<td>Hugepages</td>
</tr>
<tr>
<td>Generic Block Layer</td>
<td>Specific for Flash Latencies</td>
</tr>
</tbody>
</table>

System Configuration: 2x Intel® Xeon® E5-2695v4 (HT off), Intel® Speed Step enabled, Intel® Turbo Boost Technology disabled, 8x 8GB DDR4 2133 MT/s, 1 DIMM per channel, CentOS® Linux® 7.2, Linux kernel 4.7.0-rc1, 1x Intel® P3700 NVMe SSD (800GB), 4x per CPU socket, FW 8DV10102, I/O workload 4KB random read, Queue Depth: 1 per SSD, Performance measured by Intel using SPDK overhead tool, Linux kernel data using Linux AIO
A WORD ON THE SPDK NVME DRIVER

SPDK saturates 8 NVMe SSDs with a single CPU core!

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• Systems with multiple NVMe SSDs capable of millions of IOPS
• SPDK enables:
  • more CPU cycles for storage services
  • lower I/O latency
SPDK reduces NVMe over Fabrics software overhead up to 10x!

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SPDK HOST+TARGET VS KERNEL HOST+TARGET

Avg. I/O Round Trip Time
Kernel vs. SPDK NVMe-ofF Stacks
Coldstream, Perf, qd=1

SPDK reduces Optane NVMe-ofF latency by 44%, write latency by 32%!

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Disclaimer: Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products.

System Configuration: 2x Intel® Xeon® E5-2695v4 (HT on, Intel® Speed Step enabled, Intel® Turbo Boost Technology enabled, 64GB DDR4 Memory, 8x 8GB DDR4 2400 MT/s, Ubuntu 16.04.1, Linux kernel 4.10.1, 1x 25GbE Mellanox 2P CX-4, CX-4 FW= 14.16.1020, mlx5_core= 3.0-1 driver, 1 ColdStream, connected to socket 0, 4KB Random Read I/O 1 initiators, each initiator connected to bx NVMe-oF subsystems using 2P 25GbE Mellanox. Performance measured by Intel using SPDK perf tool, 4KB Random Read I/O, Queue Depth: 1/NVMe-oF subsystem. numjobs 1, 300 sec runtime, direct=1, norandommap=1

- 20 us round trip time measured from NVMe-oF initiator
- Out of 20ussec, ~7 us spent in NVMe controller
- 12-13 usmeasured time in the fabric and kernel NVMe-oF initiator
- SPDK NVMf target adds just 100-200 nsto fabric overhead
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- 14 usround trip time measured from NVMe client
- Out of 14usec, ~7 usspent in NVMe controller
- 7 usmeasured time in the fabric and SPDK NVMe-oF initiator
- SPDK NVMe target adds just 100-200 nsec to fabric overhead
14th ANNUAL WORKSHOP 2018

THANK YOU

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