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Where Does SPDK Fit in the NVMe-oF™ Landscape?

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10:00 am PT

Today's Presenters

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SNIA-At-A-Glance

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- Virtualized storage
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Agenda

- Overview of the SPDK Project
- Key NVMe-oF Use Cases with SPDK
- SPDK NVMe-oF Architecture and Design
- Performance Data
- Q&A

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Overview of the SPDK Project

What is SPDK?

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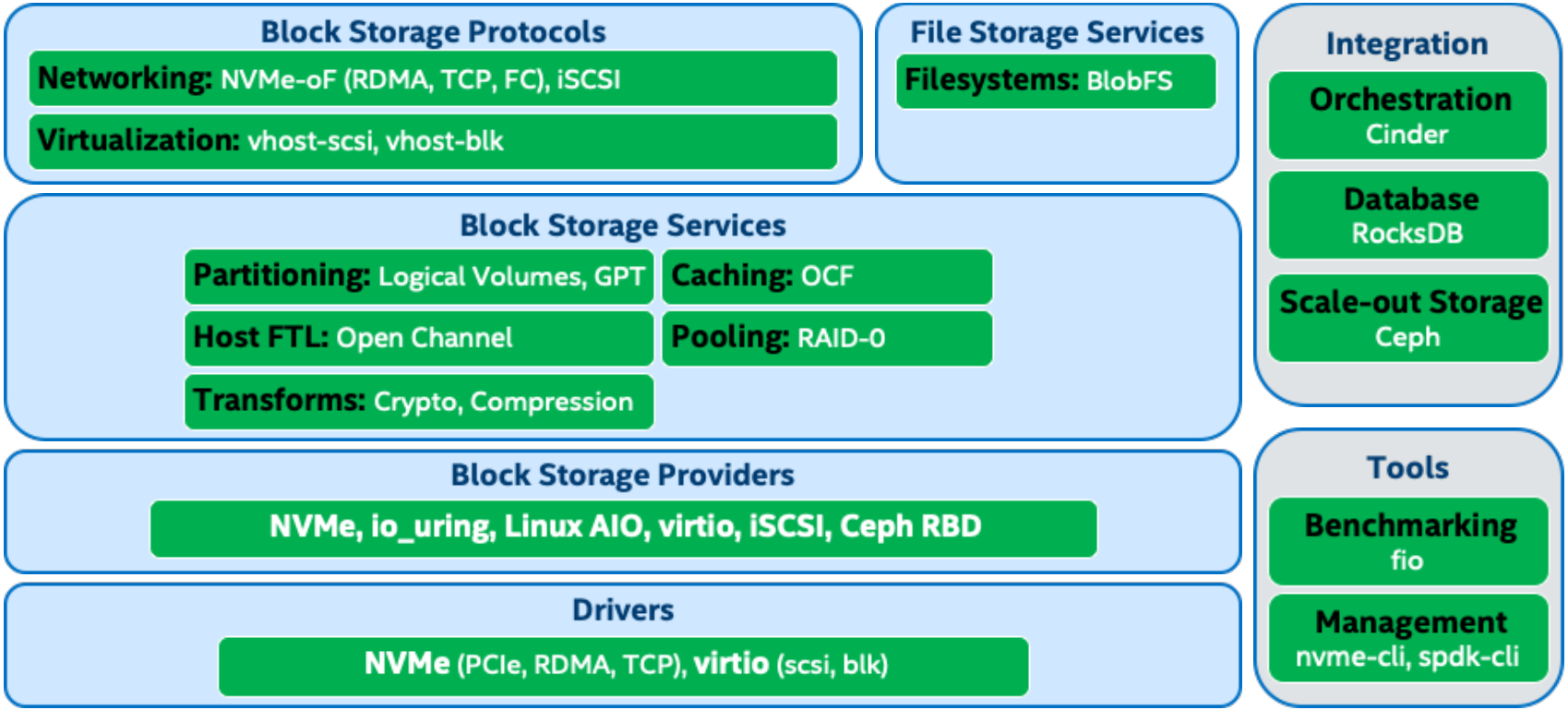
- Storage Performance Development Kit
  - Open source project
  - Framework for highly performant and efficient storage software
  - Userspace and polled mode programming model
  - Special focus on NVM Express (and NVMe over Fabrics!)
  - Includes storage networking and storage virtualization
  - Discrete libraries and fully-functional applications

What is SPDK?

- Project History
  - 2013: SPDK starts as an internal project at Intel
  - 2015: NVMe driver released on GitHub
  - 2016: First contributor outside of Intel
  - 2017: First core maintainer outside of Intel
  - 2018: NVMe/TCP support released in-step with specification
  - 2019: 700+ patches from 50+ contributors outside of Intel

Architecture Diagram



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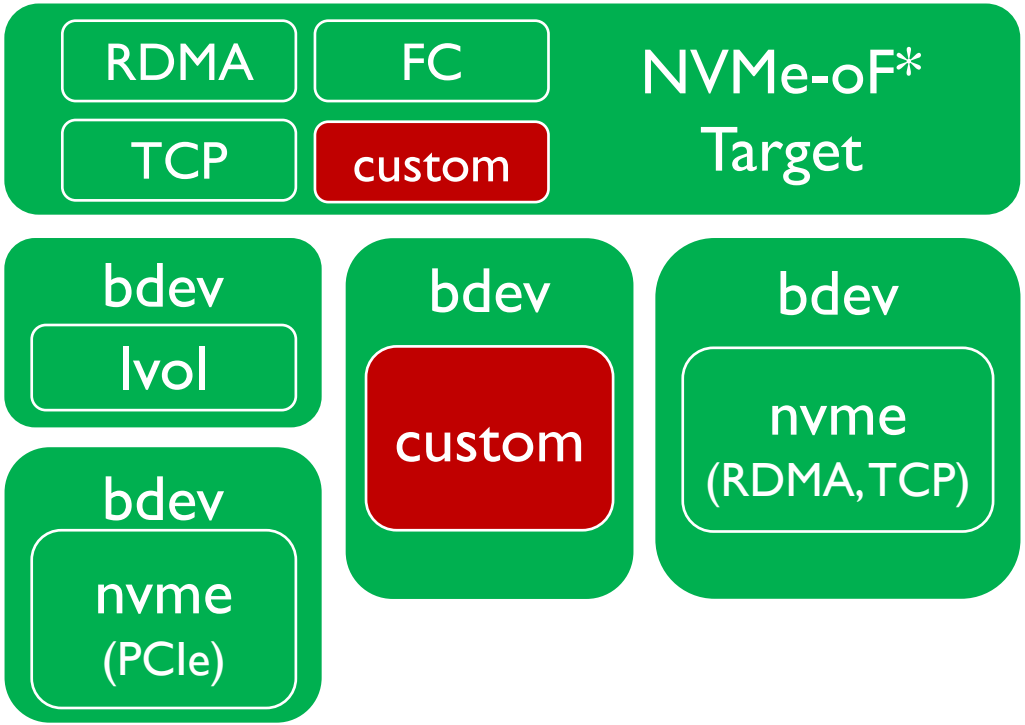
Key NVMe-oF Use Cases with SPDK

Determining Factors

- Performance and efficiency requirements
  - SPDK capable of up to millions of IOPs per CPU core
- Integration with existing software
  - SPDK provides well-defined APIs for integrating custom modules
- Customization
  - SPDK enables use of optional or vendor-specific NVMe features with little or no performance impact
- Licensing
  - SPDK is BSD licensed

Use Cases



- NVMe-oF target
- Basic block services
- Custom block services
  - Including integrating existing block storage stacks
- Custom transports
- Polled mode access to remote storage

Where is SPDK not suited?

- Reduced performance requirements
  - Kernel-based interrupt-driven storage software is typically sufficient for lower IOPs workloads
- Integration with legacy software
  - SPDK APIs designed for asynchronous operation with relatively fixed number of threads
- Support requirements
  - Kernel-based solutions may provide paid support options that are not available with SPDK
- General purpose filesystem requirements

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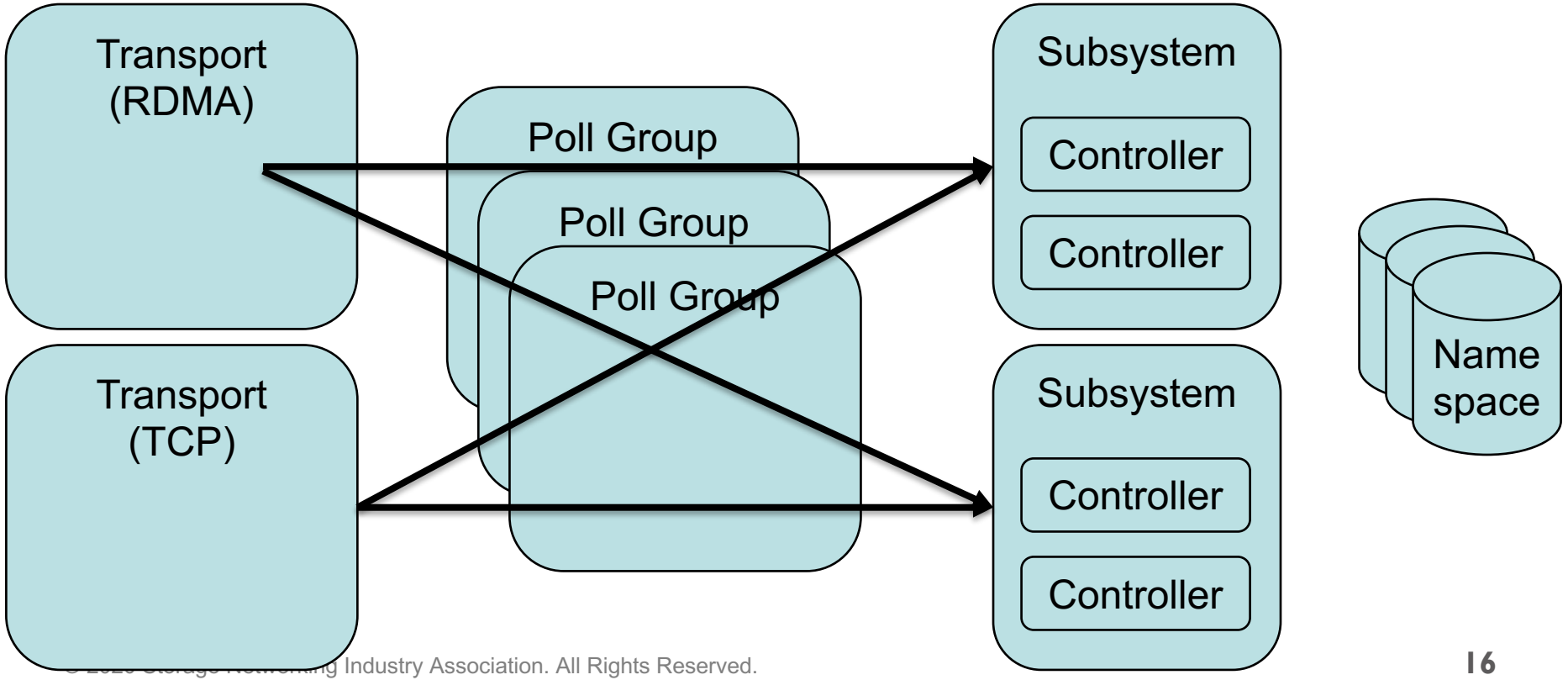
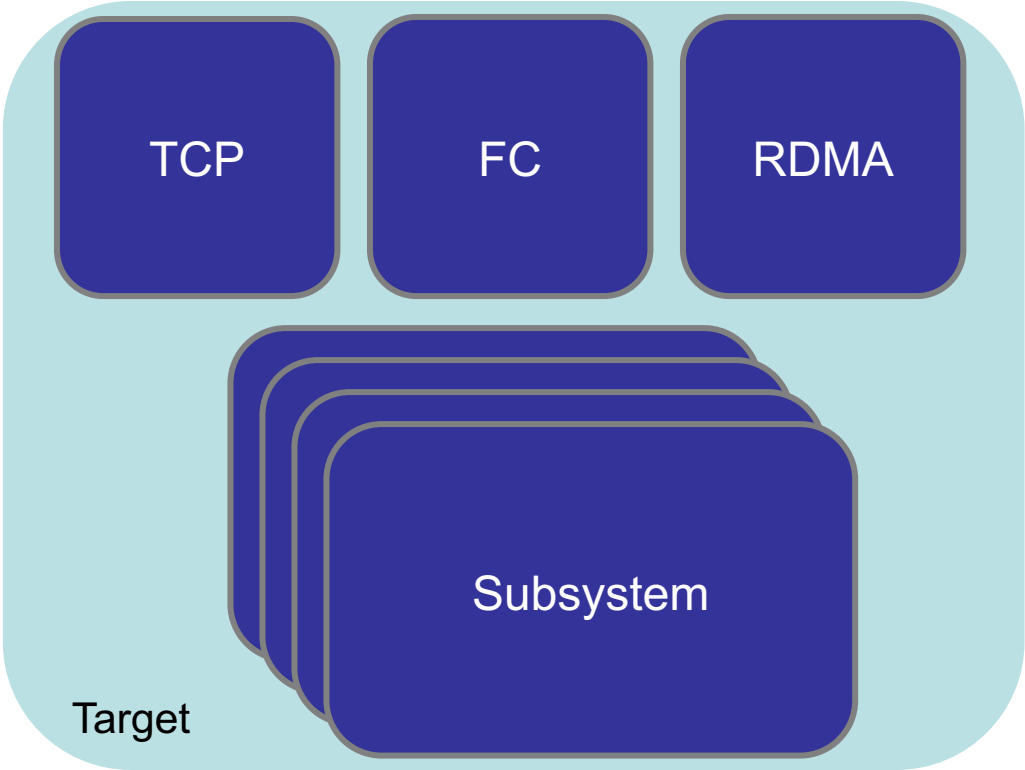
SPDK NVMe-oF Architecture and Design

NVMe-oF Target Architecture



NVMe-oF Primitives

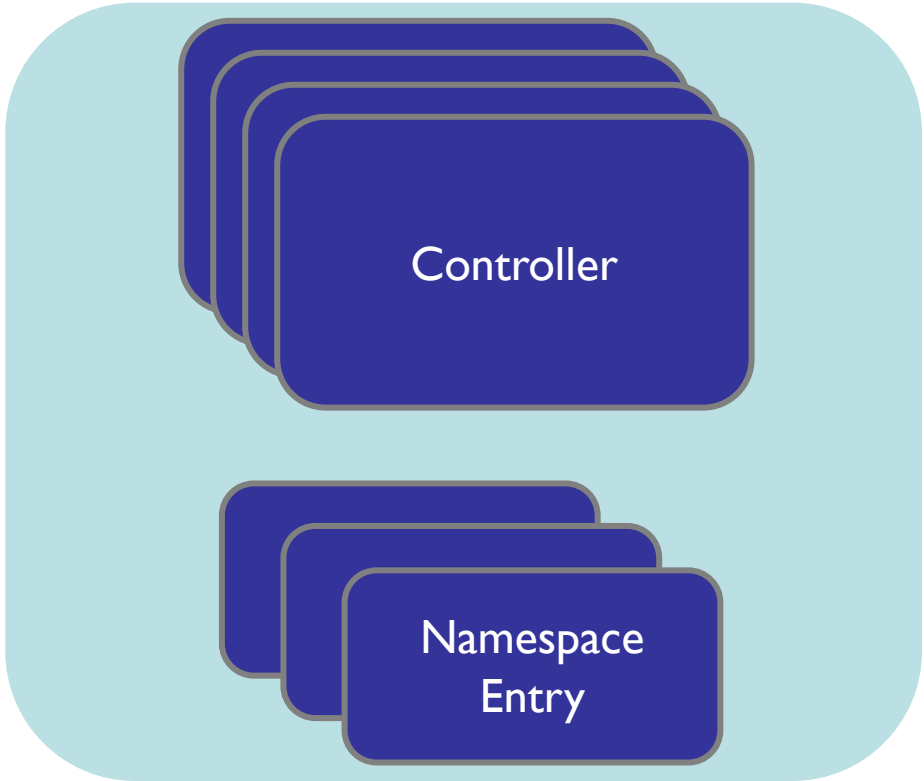
- spdk_nvmf_tgt
  - spdk_nvmf_subsystem
  - spdk_nvmf_transport



NVMe-oF Subsystems

- Subsystems are **global**
- Controller – Network session
- Namespace – Set of logical blocks

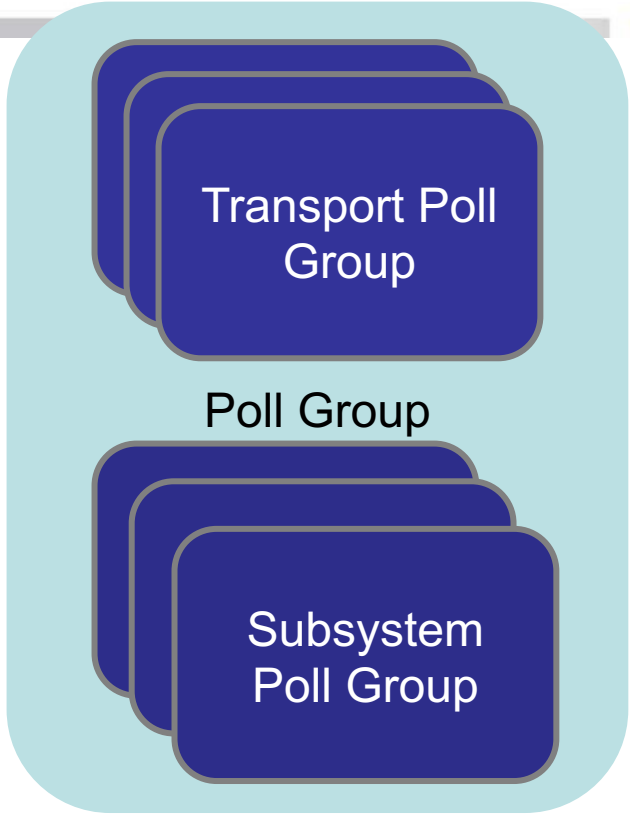
- Subsystems are **access control lists**



NVMe-oF Primitives

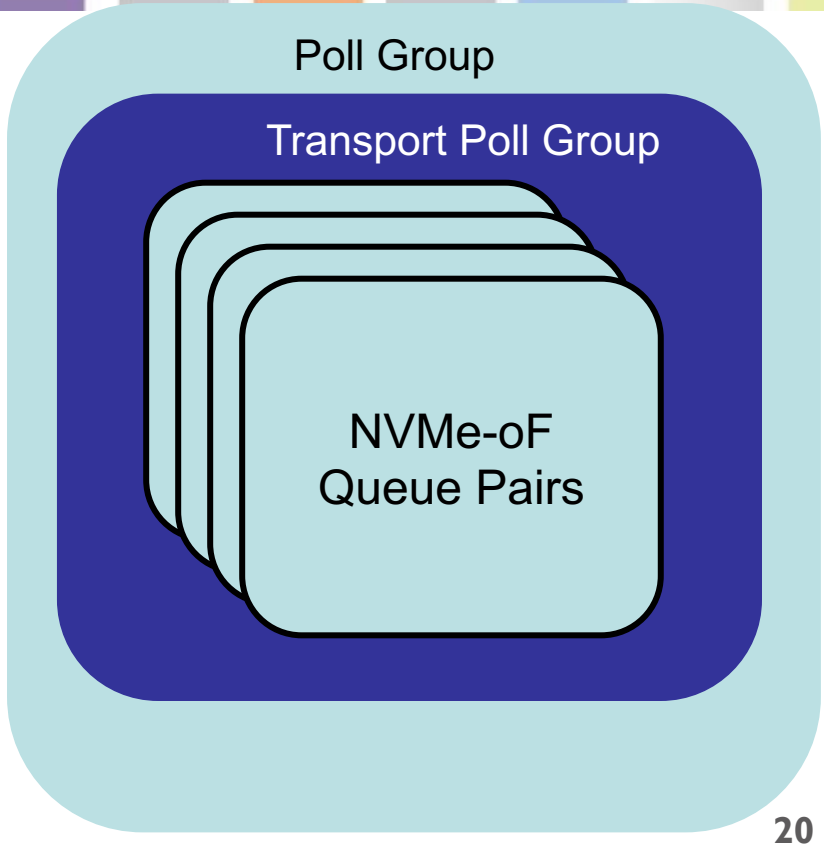
- spdk_nvmf_poll_group
  - spdk_nvmf_subsystem_poll_group
  - spdk_nvmf_transport_poll_group

Per-thread Scope



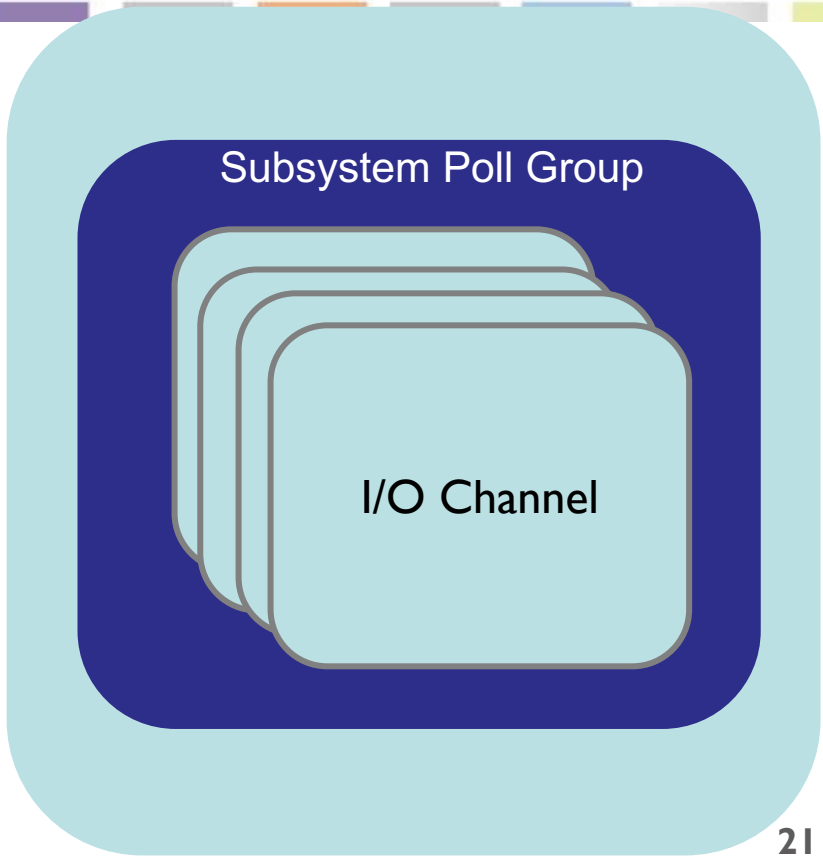
NVMe-oF Transport Poll Groups

- Per-thread collection of transport data
- TCP: NVMe-oF queue pair is a socket
- Uses a transport-specific mechanism to efficiently poll the group
  - TCP: epoll/kqueue
- The queue pairs are not necessarily for the same controller/subsystem/host

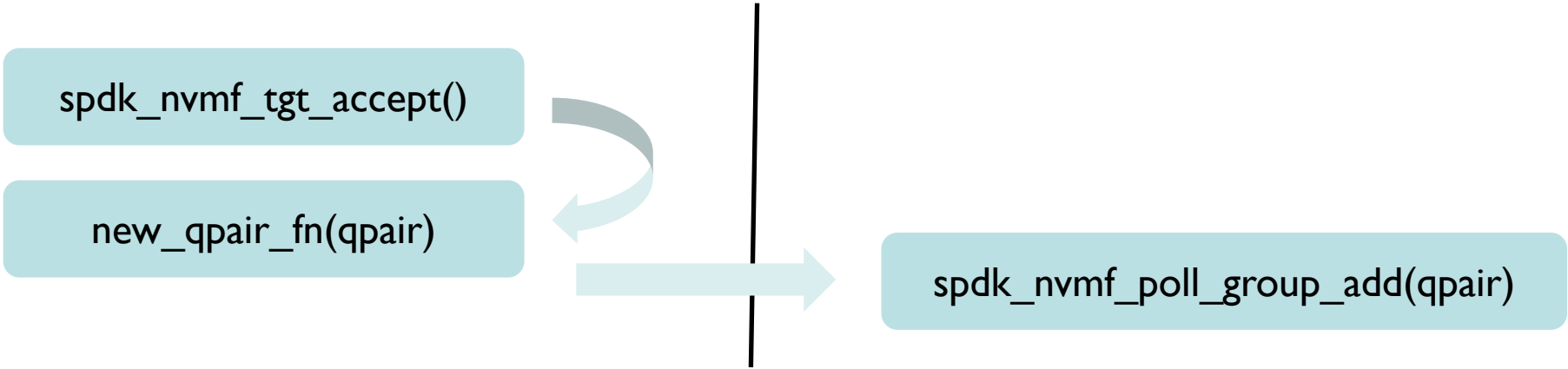


NVMe-oF Subsystem Poll Groups

- 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.

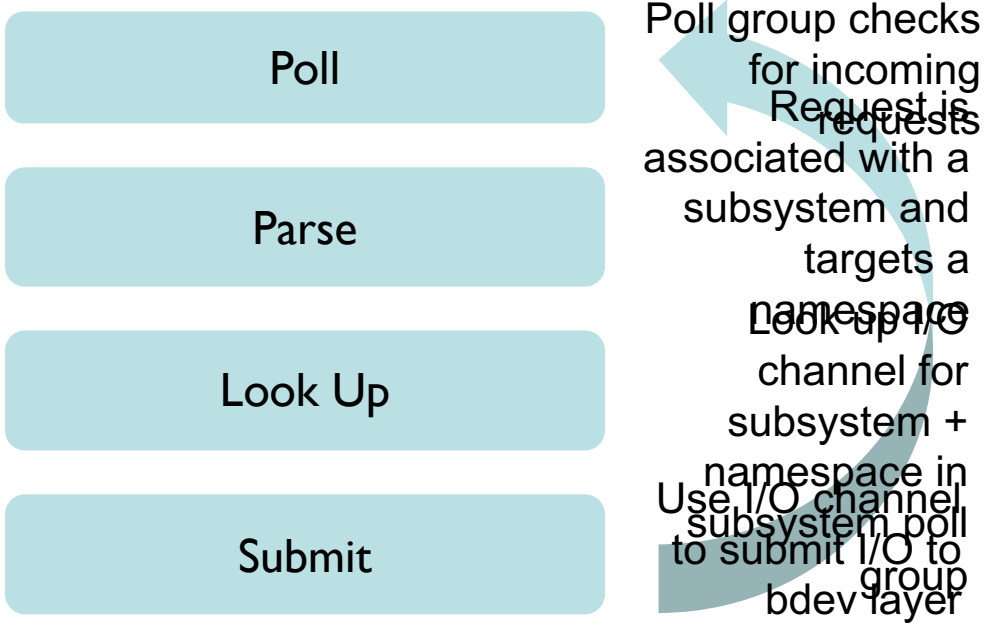


Accepting a New Connection



Performing an I/O

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



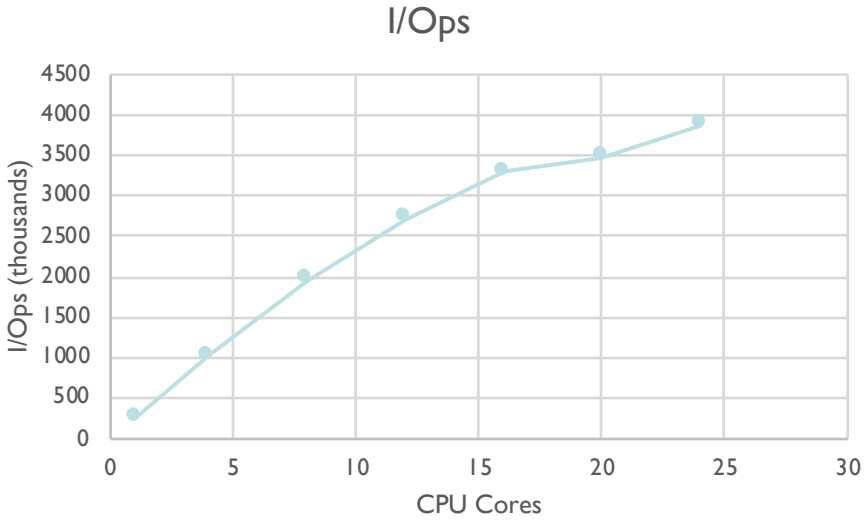
NVMe-oF Host Architecture

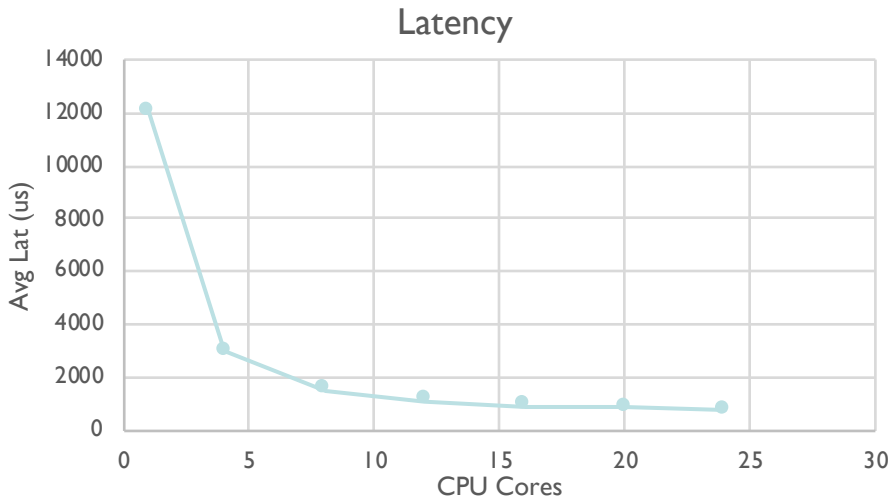
- Same library/API as local PCIe NVMe driver
- Pluggable Transports
- No poll groups
  - Doing a spdk_nvme_connect() creates an spdk_nvme_ctrlr (network session) which includes the admin qpair.
  - I/O qpairs are polled directly

Performance Data

NVMe-oF Performance: TCP

Random read/write 70/30 @ 4K QD=64

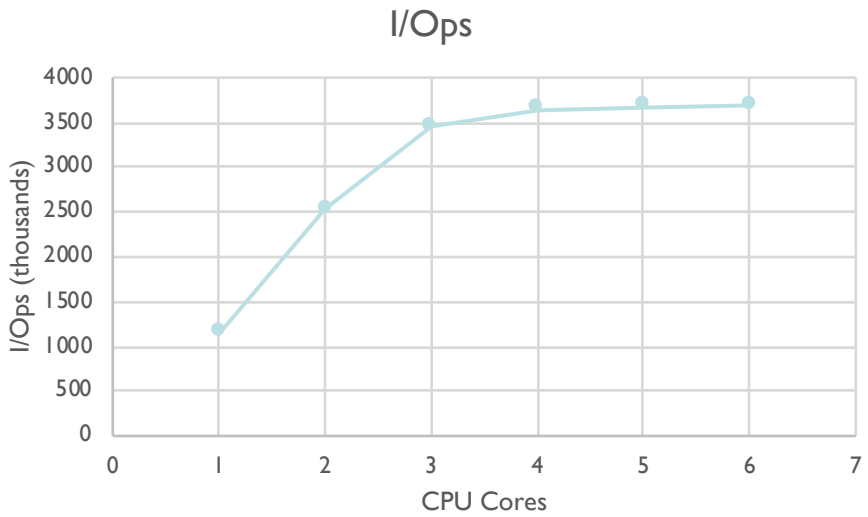


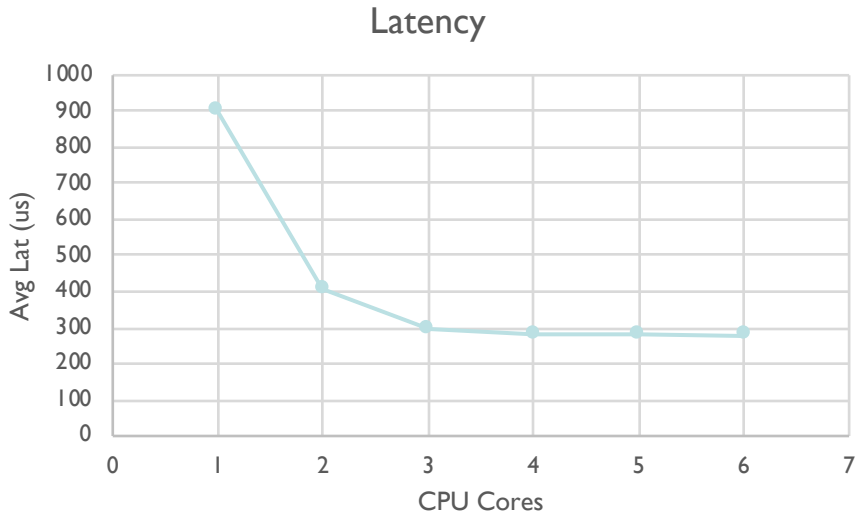


https://dqtibwqq6s6ux.cloudfront.net/download/performance-reports/SPDK_vhost_perf_report_1910.pdf

NVMe-oF Performance: RDMA

Random read/write 70/30 @ 4K QD=64





https://dqtibwqq6s6ux.cloudfront.net/download/performance-reports/SPDK_19.04_NVMeOF_RDMA_benchmark_report.pdf

Q&A

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- This webcast and a PDF of the slides will be posted to the SNIA Networking Storage Forum (NSF) website and available on-demand at www.snia.org/forums/nsf/knowledge/webcasts
- A full Q&A from this webcast, including answers to questions we couldn't get to today, will be posted to the SNIA-NSF blog: sniansfblog.org
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More Resources

- Let's Talk Fabrics – NVMe over Fabrics
  SNIAVideo YouTube: https://youtu.be/HfcZwkPzj4w
- What NVMe/TCP Means for Networked Storage
  On-Demand Webcast: https://www.brighttalk.com/webcast/663/344698
- Under the Hood with NVMe over Fabrics
  On-Demand Webcast: https://www.brighttalk.com/webcast/663/175515
- What's New in NVM Express:
  SNIAVideo YouTube: https://youtu.be/m8nq2BzawNk
- The Performance Impact of NVMe and NVMe over Fabrics
  On-Demand Webcast: https://www.brighttalk.com/webcast/663/132761
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