New storage Paradigm

Johann Lombardi, Principal Engineer
Extreme Storage Architecture & Development, Intel
notices and disclaimers

Intel technologies' features and benefits depend on system configuration and may require enabled hardware, software or service activation. Performance varies depending on system configuration.

No computer system can be absolutely secure.

Tests document performance of components on a particular test, in specific systems. Differences in hardware, software, or configuration will affect actual performance. For more complete information about performance and benchmark results, visit http://www.intel.com/benchmarks.

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 complete information visit http://www.intel.com/benchmarks.

Intel® Advanced Vector Extensions (Intel® AVX)* provides higher throughput to certain processor operations. Due to varying processor power characteristics, utilizing AVX instructions may cause a) some parts to operate at less than the rated frequency and b) some parts with Intel® Turbo Boost Technology 2.0 to not achieve any or maximum turbo frequencies. Performance varies depending on hardware, software, and system configuration and you can learn more at http://www.intel.com/go/turbo.

Intel's compilers may or may not optimize to the same degree for non-Intel microprocessors for optimizations that are not unique to Intel microprocessors. These optimizations include SSE2, SSE3, and SSSE3 instruction sets and other optimizations. Intel does not guarantee the availability, functionality, or effectiveness of any optimization on microprocessors not manufactured by Intel. Microprocessor-dependent optimizations in this product are intended for use with Intel microprocessors. Certain optimizations not specific to Intel microarchitecture are reserved for Intel microprocessors. Please refer to the applicable product User and Reference Guides for more information regarding the specific instruction sets covered by this notice.

Cost reduction scenarios described are intended as examples of how a given Intel-based product, in the specified circumstances and configurations, may affect future costs and provide cost savings. Circumstances will vary. Intel does not guarantee any costs or cost reduction.

Intel does not control or audit third-party benchmark data or the web sites referenced in this document. You should visit the referenced web site and confirm whether referenced data are accurate.

Intel, the Intel logo, and Intel Xeon are trademarks of Intel Corporation in the U.S. and/or other countries.

*Other names and brands may be claimed as property of others.

© 2018 Intel Corporation.
Evolving Storage Needs

Traditional HPC
Modeling & Simulation

Data Science Analytics
Analysis, Search & Compare

Artificial Intelligence
Decision making
REARCHITECTING THE MEMORY/STORAGE HIERARCHY

Memory

Persistent Memory

Storage

Improving SSD performance

Delivering efficient storage

Intel® QLC 3D Nand SSD

HDD / TAPE

Copyright © 2018 Intel® Corporation
End-to-End Performance

Hardware

High msg rate & bandwidth
HW: Intel® Omni-Path Ethernet

High IOPS & bandwidth
HW: Intel® Optane DC Persistent Memory
Intel® Optane DC SSDs
Intel® 3D-NAND SSDs
End-to-End Performance
Software Building Blocks

High msg rate & bandwidth
HW: Intel® Omni-Path Ethernet
SW: libfabric, Mercury, ...
in userspace

High IOPS & bandwidth
HW: Intel® Optane DC Persistent Memory
  Intel® Optane DC SSDs
  Intel® 3D-NAND SSDs
SW: PMDK, SPDK, ...
in userspace
End-to-End Performance
Storage Software Stack

Fabric

High msg rate & bandwidth
HW: Intel® Omni-Path Ethernet
SW: libfabric, Mercury, ... in userspace

Storage Systems

Kernel-based PFS, disk-based fs, ...

Storage Media

High IOPS & bandwidth
HW: Intel® Optane DC Persistent Memory
Intel® Optane DC SSDs
Intel® 3D-NAND SSDs
SW: PMDK, SPDK, ... in userspace
End-to-End Performance Software Bottleneck

High msg rate & bandwidth
HW: Intel® Omni-Path Ethernet
SW: libfabric, Mercury, ... in userspace

Kernel-based PFS, disk-based fs, ...

High IOPS & bandwidth
HW: Intel® Optane DC Persistent Memory
Intel® Optane DC SSDs
Intel® 3D-NAND SSDs
SW: PMDK, SPDK, ... in userspace

Traditional storage stack entirely masks low latency & capabilities of next-gen storage technologies!
Distributed Async Object Storage

Benefits

- Built natively over new userspace PMEM/NVMe software stack
- Rich storage semantics
- High throughput/IOPS @arbitrary alignment/size
- Ultra-fine grained I/O
- Scalable communications & I/Os
- Software-managed redundancy
- Microservices architecture
- Open source
Distributed Async Object Storage

3rd Party Applications

Rich Data Models

Storage Platform

DAOS Storage Engine

Open Source Apache 2.0 License

POSIX I/O
HDF5
Apache Arrow
SQL

POSIX Container

File-per-process Container

HDF5 Container

KV store Container

Columnar DB Container

ACG Container

Control Plane

Data Plane

PMDK
SPDK

HPC Workflow

HPC Workflow

HDD

POSIX I/O

HDF5

Apache Arrow

SQL

(MediaType 3rd Party Applications)

(data 3rd Party Applications)

(PMDC 3rd Party Applications)

(SPDK 3rd Party Applications)

(MediaType Rich Data Models)

(data Rich Data Models)

(PMDC Rich Data Models)

(SPDK Rich Data Models)

(MediaType Storage Platform)

(data Storage Platform)

(PMDC Storage Platform)

(SPDK Storage Platform)

(MediaType Storage Media)

(data Storage Media)

(PMDC Storage Media)

(SPDK Storage Media)
Mercury userspace function shipping

- **MPI** equivalent communications **latency**
- Built over libfabric

Applications link directly with DAOS lib

- Direct call, no context switch
- Small memory **footprint**
- No locking, caching or data copy

Userspace DAOS server

- Mmap non-volatile memory via PMDK
- NVMe access through SPDK/Blobstore
DAOS Development & Exascale HPC

- Prototype over Lustre*
- Standalone prototype
  - OS-bypass
  - Persistent memory
  - Replication & self healing
- Fast Forward Storage & I/O
- Extreme Scale Storage & I/O
- Stabilization & new features for Exascale
- Productization for Exascale deployment

*Other names and brands may be claimed as the property of others.
Resources

Source code on GitHub
- https://github.com/daos-stack/daos

Community mailing list on Groups.io
- daos@daos.groups.io
- https://daos.groups.io/g/daos

Wiki
- http://daos.io

Contact
- johann.lombardi@intel.com