Bringing AI Everywhere in HPC

High Performance Fabric Support in DAOS

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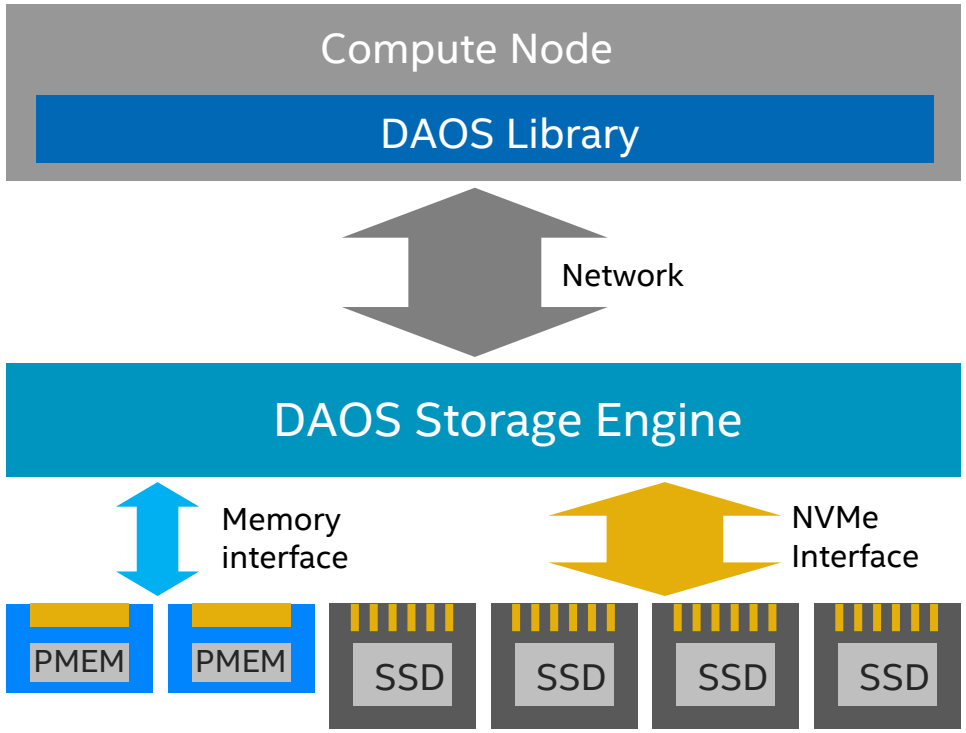
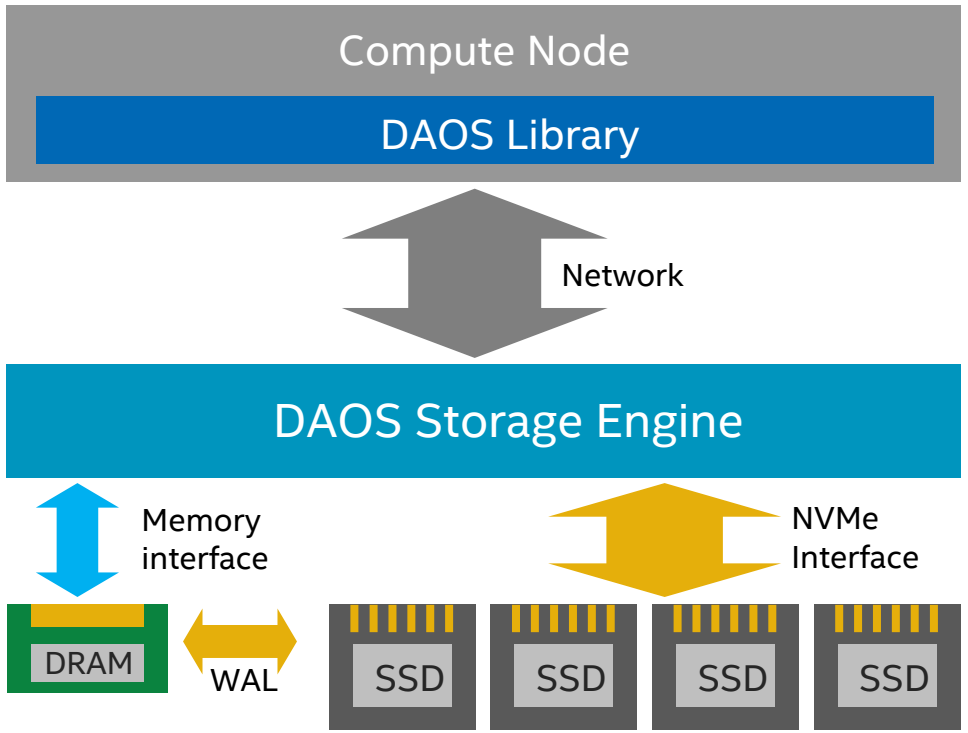
DAOS Architecture (PMem → non-PMem)

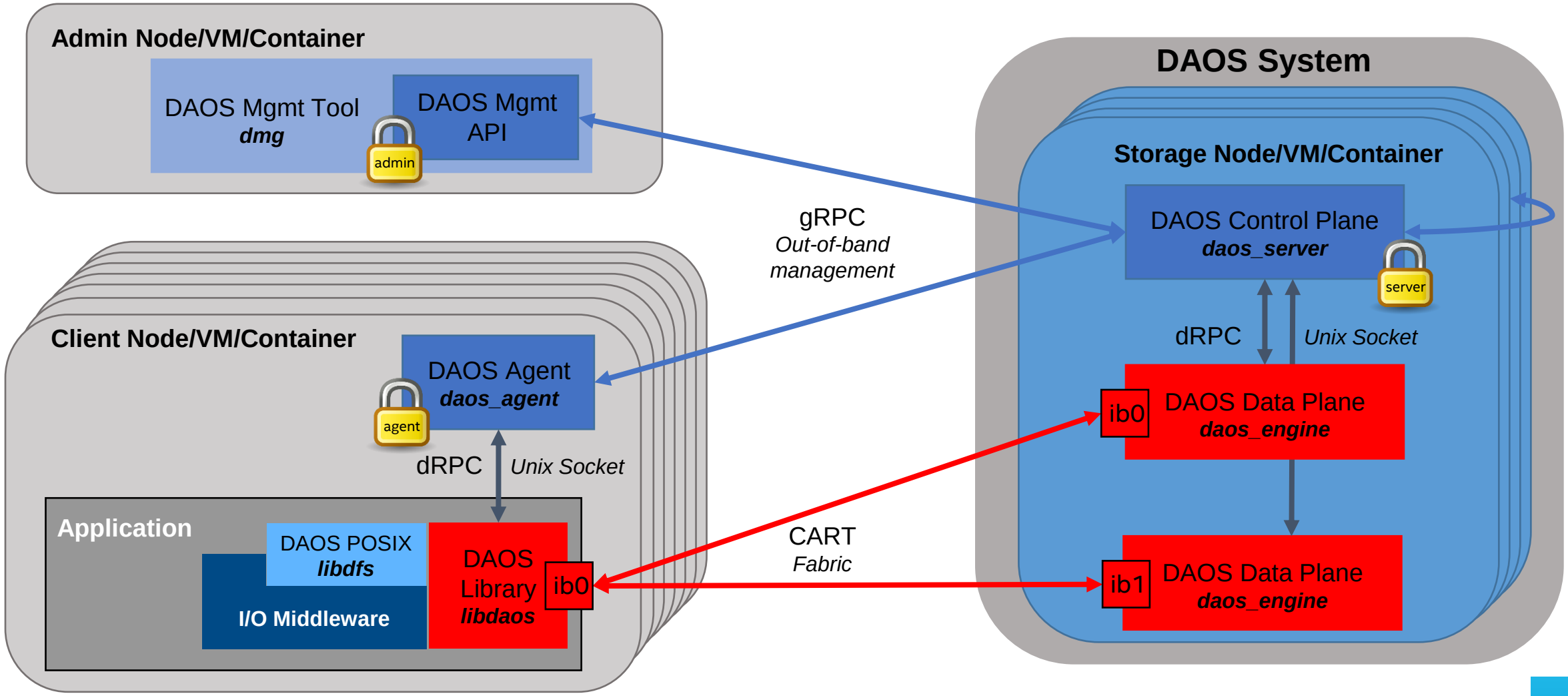


With Persistent Memory



Without Persistent Memory

DAOS Software Components



Networking in the DAOS Configuration Files

daos_server.yml

```
# To operate, DAOS will need a quorum
# of access point nodes to be available.

access_points:

- daos[01-03]


provider: ofi+verbs;ofi_rxm


engines:

-

  fabric_iface: ib0

  fabric_iface_port: 20000

-

  fabric_iface: ib1

  fabric_iface_port: 21000
```

daos_agent.yml

```
# Management service access points
# Must have the same value for all
# agents and all servers in a system.

access_points:

- daos[01-03]
```

daos_control.yml

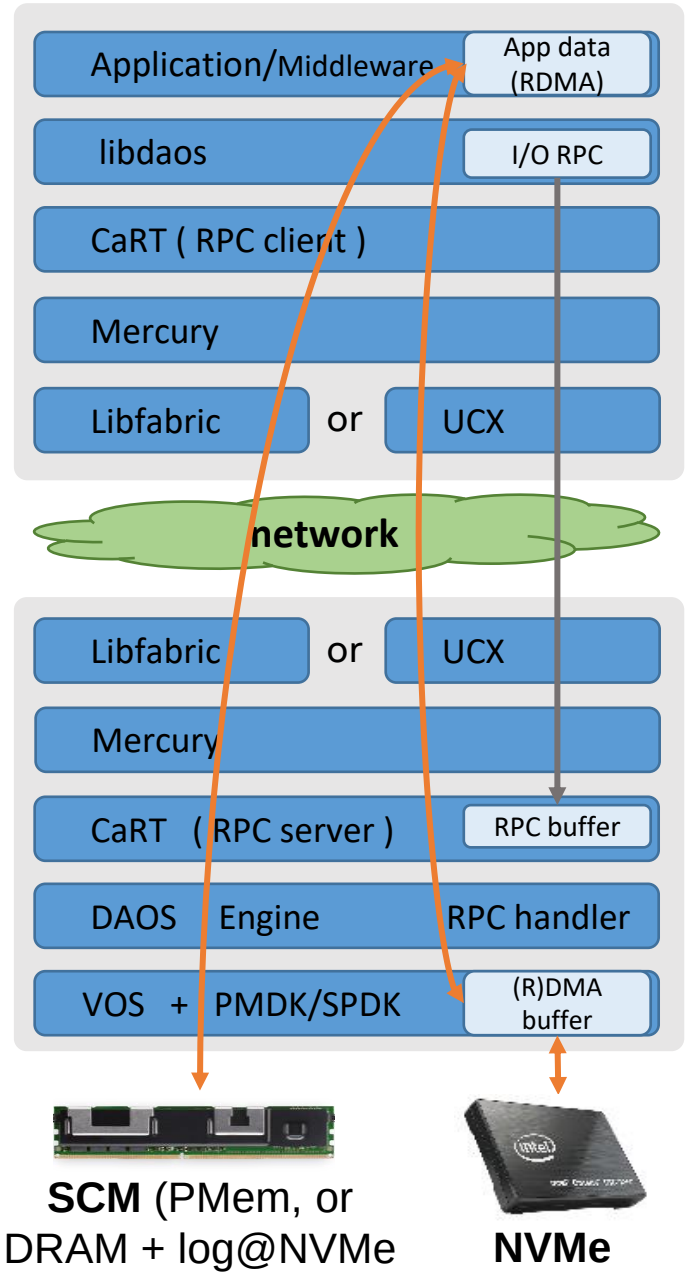
```
# Hostlist,
# a comma separated list of addresses
# (hostnames or IPv4 addresses).

hostlist:

- daos[01-42]
```

DAOS I/O Flow

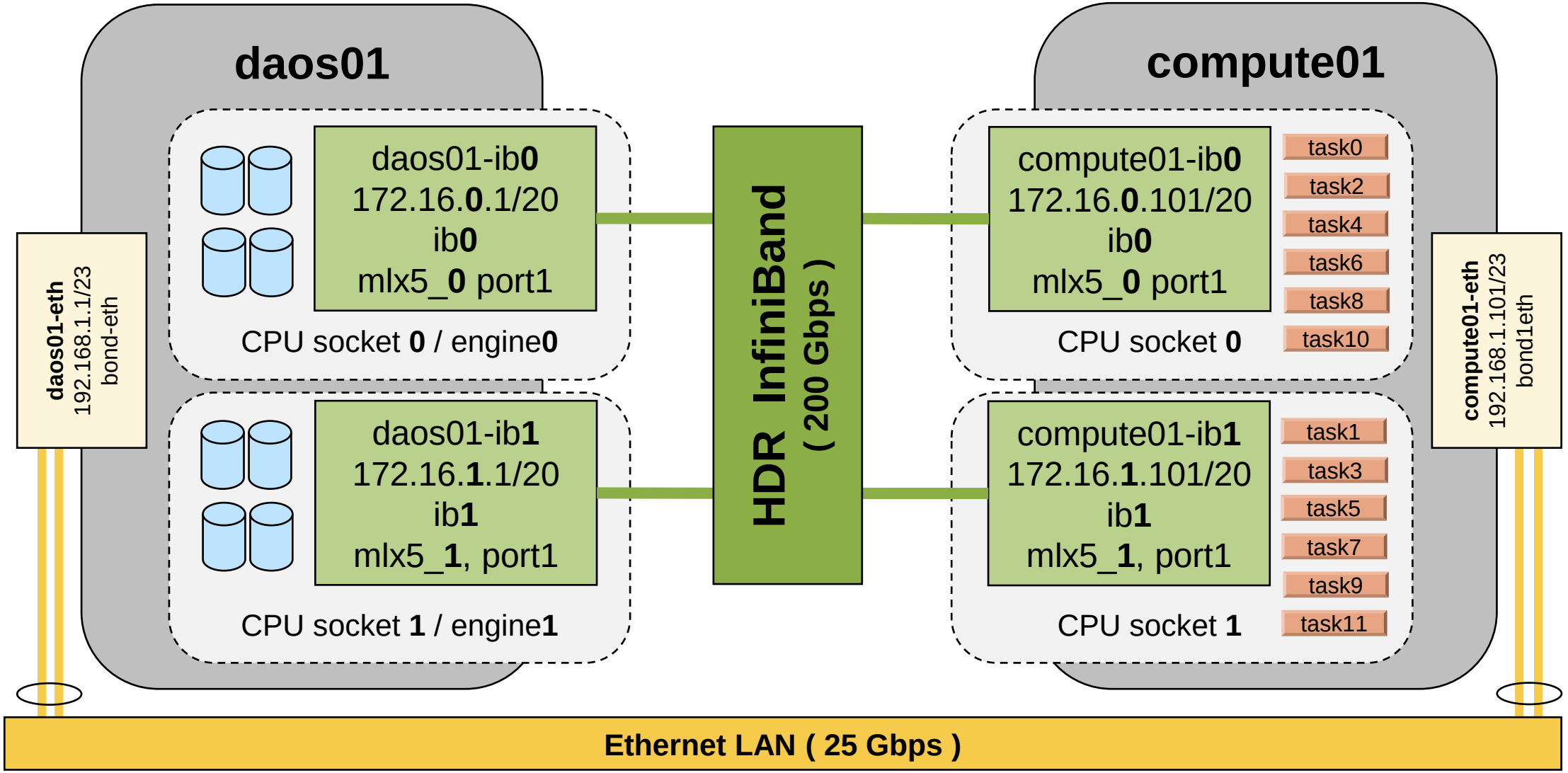
- OFI **Libfabric** – point-to-point messaging
  - Thin send/receive messaging layer, no RPCs
  - Back-end providers: tcp; verbs; cxi [; opx]
- Or **UCX** on InfiniBand (ucx+ud_x for best scaling)
- **Mercury** – p2p RPC layer over libfabric or UCX
- DAOS **C**ollective **a**nd **R**PC **T**ransport (**CaRT**)
  - Collective operations (e.g. broadcast)
  - Timeouts for RPCs; Detection of server failures
  - Flow control (managing the number of inflight RPCs)



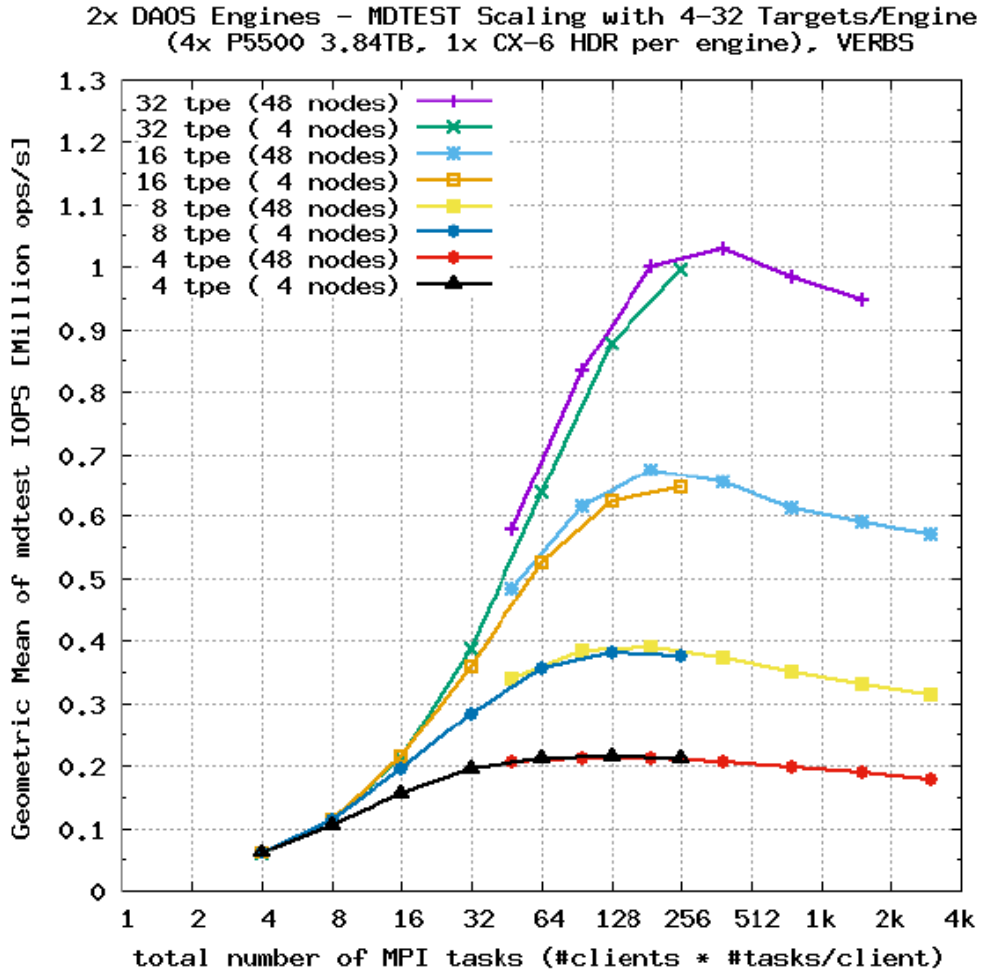
Supported High Performance Fabrics

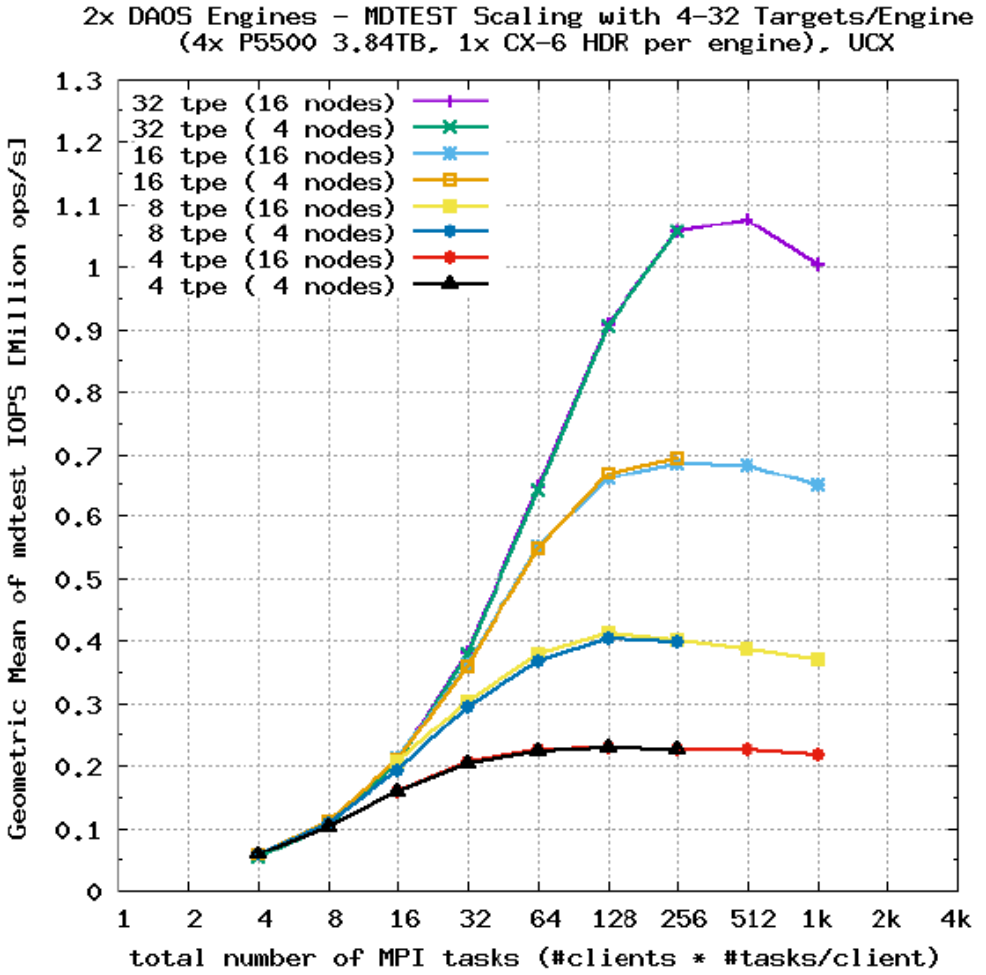
- Ethernet
  `provider: ofi+tcp [;ofi_rxm]`
- Ethernet with RoCE v2; “small” InfiniBand fabrics (see below)
  `provider: ofi+verbs;ofi_rxm`
- “Large” InfiniBand fabrics
  `provider: ucx+ud_x`
- Slingshot fabrics
  `provider: ofi+cxi`
  (using HPE-provided version of libfabric with cxi=Slingshot support)
- Omni-Path fabrics
  `provider: ofi+tcp [;ofi_rxm]`
  (Cornelis is working on DAOS support @ ofi+opx provider; not upstreamed yet)

Multiple Fabric Ports in DAOS Servers and Clients



Metadata Performance and Number of Storage Targets





mdtest scaling with #targets: ofi+verbs (left) and ucx+dc_x (right). From https://doi.org/10.1145/3581576.3581577

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How many InfiniBand Queue Pairs does RC need?

- On a DAOS client, each MPI task needs to connect to all storage targets on all daos_engine instances:
  - 56 cores/client-port * (42 servers * 2 engines/server * 4 targets/engine) = 18 816 QPs
- On a DAOS server, each storage target must connect to all MPI tasks on all clients:
  - 4 targets/engine * (240 clients * 2 sockets/client * 56 cores/socket) = 107 520 QPs
  - All targets also connect to all other targets: 4 tgt * (42 srv * 2 eng/srv * 4 tgt) = 1344 QPs
- But NVIDIA ConnectX-6 adapters support only 128k QPs:

```
i20r01c06s10:~ # ibv_devinfo -v | egrep "^hca|max_qp:“
hca_id: mlx5_0
        max_qp:                                 131072
hca_id: mlx5_1
        max_qp:                                 131072
```

➔ For “large” InfiniBand fabrics, it’s better to use UCX **with** UD (not RC or DC)…

How many InfiniBand Queue Pairs does RC need?

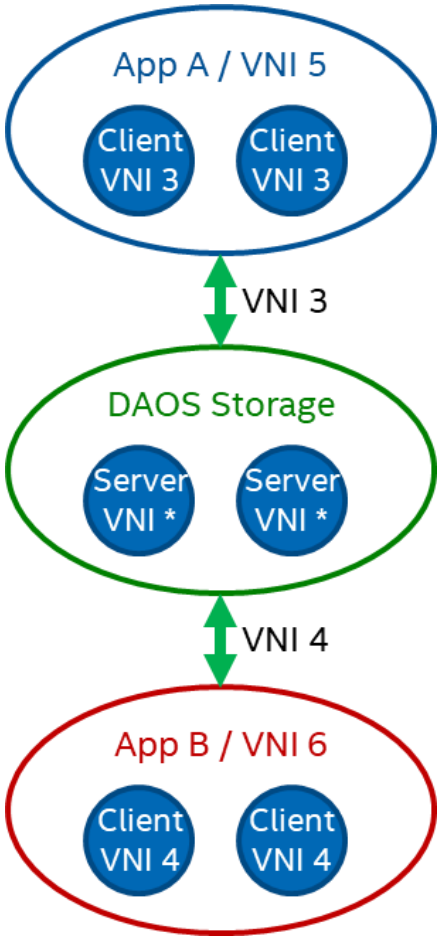
- On a DAOS client, each MPI task needs to connect to all storage targets on all daos_engine instances:
  - 56 cores/client-port * (42 servers * 2 engines/server * 24 targets/engine) = 112 896 QPs
- On a DAOS server, each storage target must connect to all MPI tasks on all clients:
  - 24 targets/engine * (240 clients * 2 sockets/client * 56 cores/socket) = 645 110 QPs
  - All targets also connect to all other targets: 24 tgt * (42 srv * 2 eng/srv * 24 tgt) = 48 384 QPs
- But NVIDIA ConnectX-6 adapters support only 128k QPs:

```
i20r01c06s10:~ # ibv_devinfo -v | egrep "^hca|max_qp:“
hca_id: mlx5_0
        max_qp:                                 131072
hca_id: mlx5_1
        max_qp:                                 131072
```

➔ For “large” InfiniBand fabrics, it’s better to use UCX with UD (not RC or DC)…

Slingshot Security Framework – VNI for Client/Server

- Slingshot uses Virtual Network Identifiers (VNIs) for security isolation (like VLAN in Ethernet, P-Key in IB)
- Each job runs with its own VNI
  - e.g. for MPI messaging
- All jobs must also communicate with the DAOS servers
  - sharing "server VNIs" across jobs would compromise the job isolation
  - solution: make DAOS servers "promiscuous" for a range of VNIs, and assign a separate VNI from this range to each job
- Needed libfabric extension for authorization keyrings
  - original libfabric only supports one auth key/endpoint



For more information on the DAOS Foundation and the DAOS Project, please visit https://daos.io/

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