In-Storage Data Integrity Check

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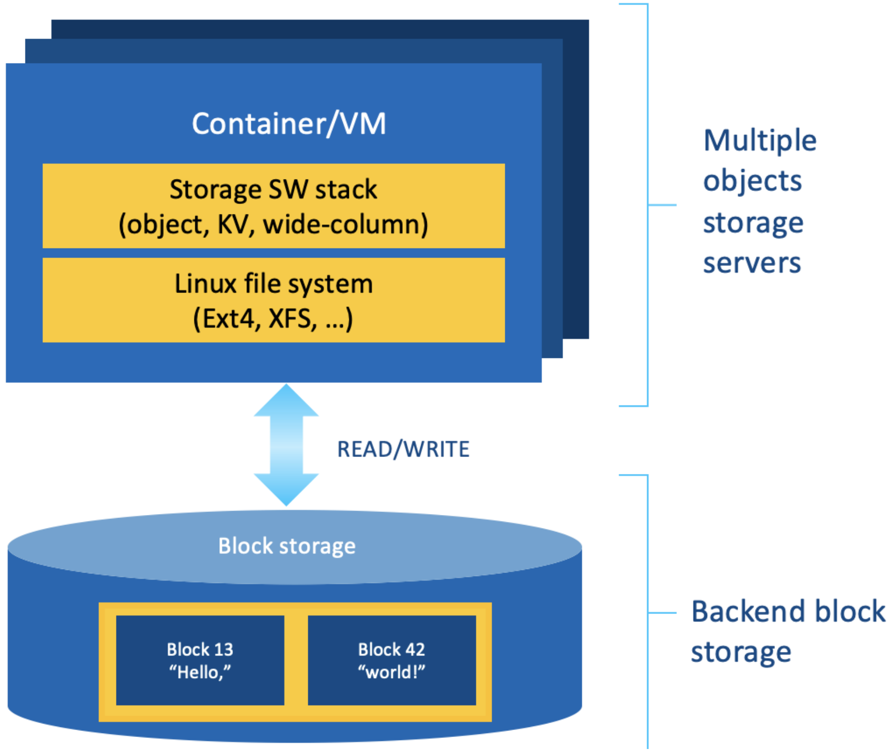
Outline

- Use case description
- Why use CS?
- Software stack
- CS implementation
- Distributed processing and scalability
- Future work
- Conclusion

Use Case and Problem Statement

Using computational storage for expensive data integrity checks



MINIO | ceph | openstack | cassandra | …

Storage servers regularly scrub all data –

1. Read all data from local FS
2. Hash data (CRC-32C, MD5, Highway Hash)
3. Compare with previously stored hashes

Significant READ traffic generated

Data integrity check is:

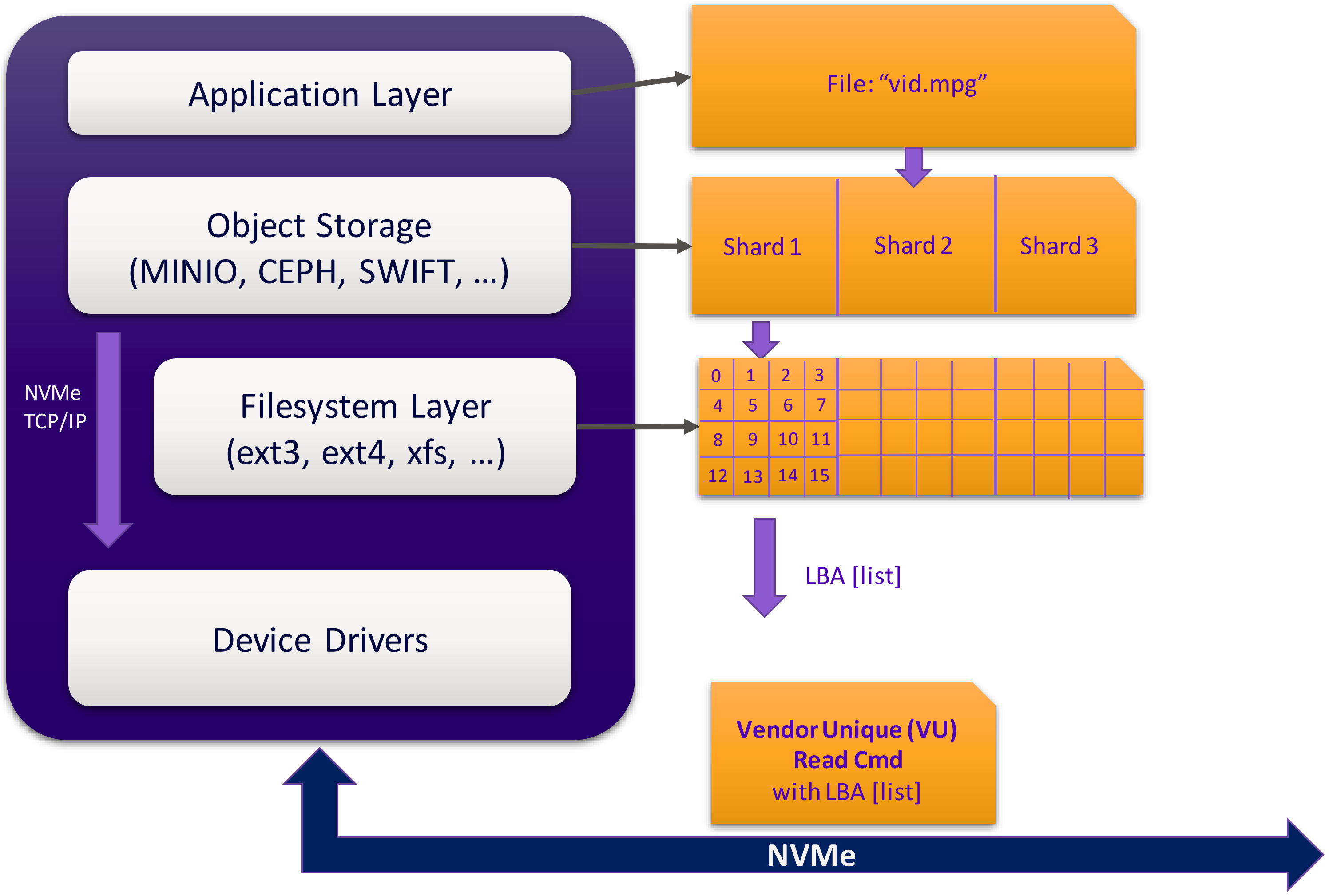
- X Compute intensive
- X Read intensive (SSD & PCIe bus)
- X Memory intensive (host)
- X Not scalable

Why Use CS For This Use Case?

Flash Memory Summit

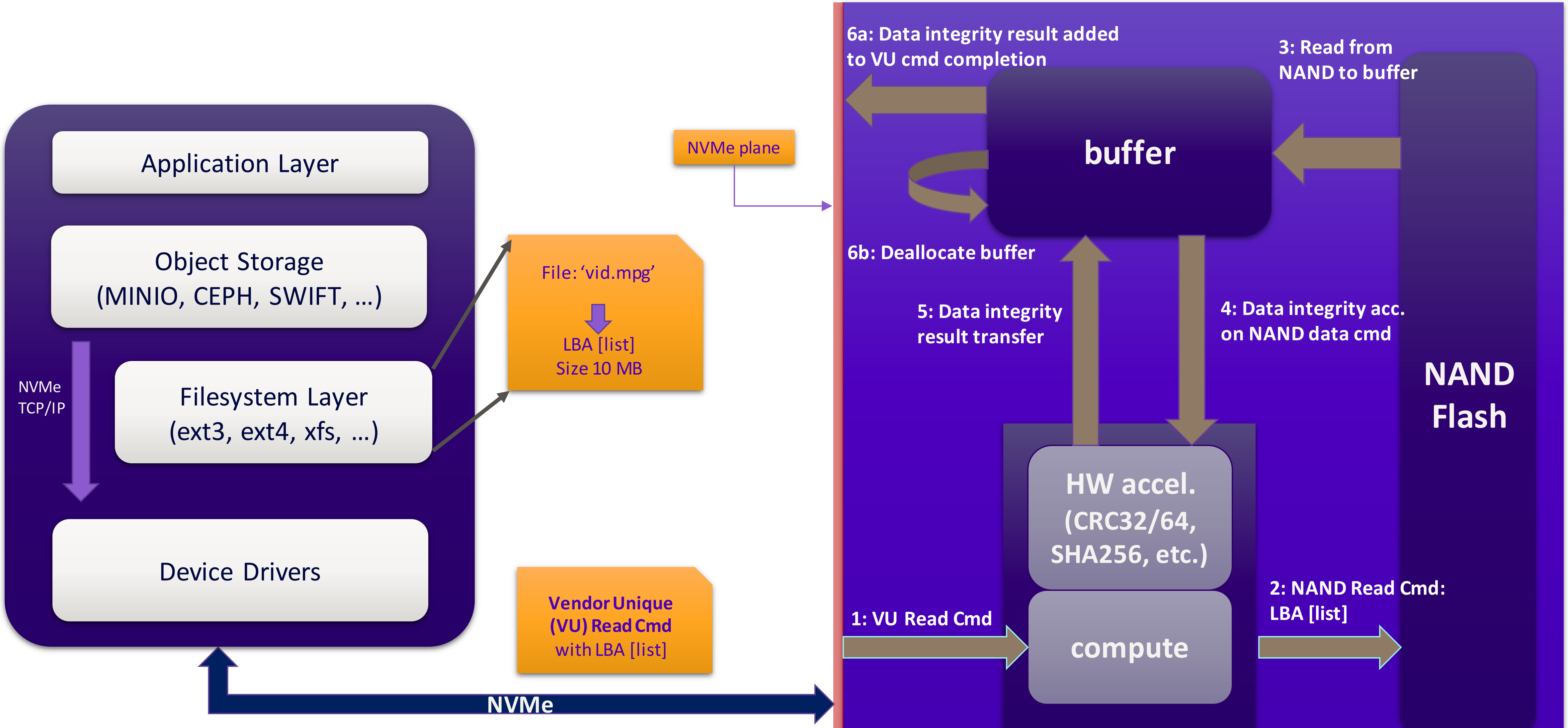
- ✓ Off-load the host
    - ✓ The host is only interested in the data integrity check results
- ✓ Reduces PCIe traffic
    - ✓ No need to consume bandwidth and power to move the raw data to the host
- ✓ Reduces host memory footprint
    - ✓ All data required for processing is contained in the drive
- ✓ Scalable with storage
    - ✓ Performance increases as drives are added

Software Stack



- Data integrity validation of the object shard is decoupled from data transfer.
- Data integrity hash calculation is done by the CSD.
- The object storage node validates the result.

CSD Implementation

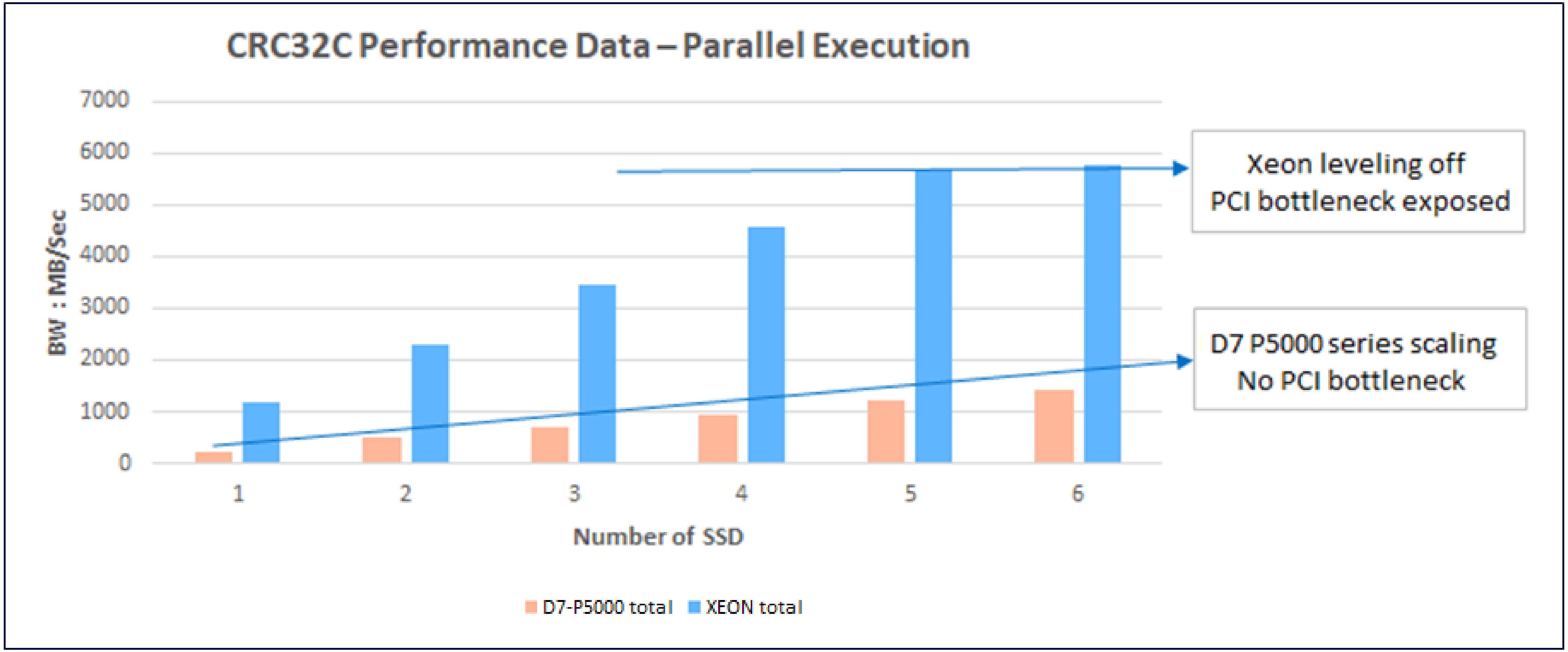


CSD Implementation

Flash Memory Summit

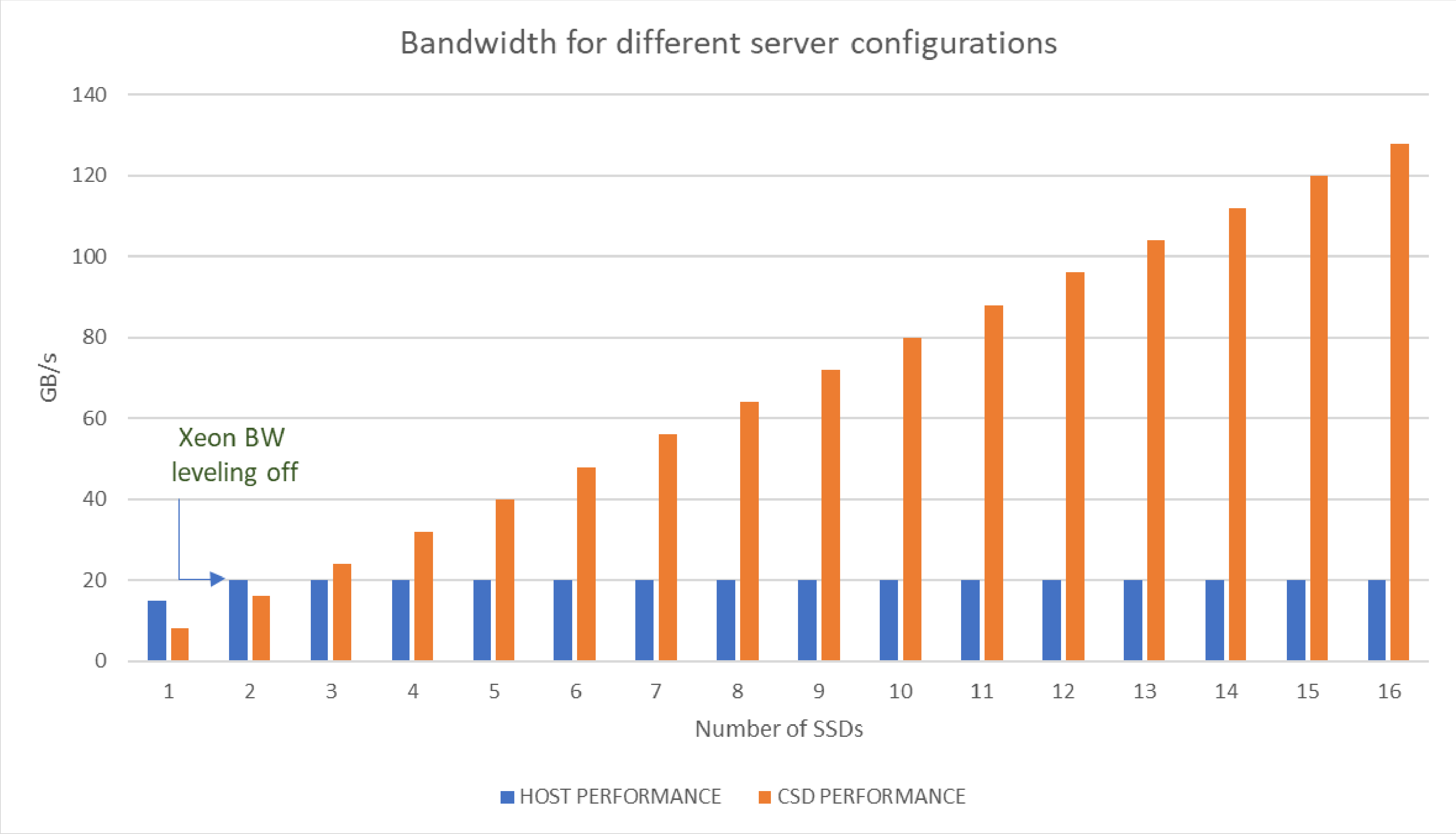
- Gen5 off-the-shelf product
- Single ASIC controller
    - Low cost
    - High energy efficiency
    - High performance
- Off-the-shelf NVMe driver
- Ready to support TP4091 & TP4131

Performance and Scalability (1)



Presented by Intel Labs at FMS 2022

Performance and Scalability (2)



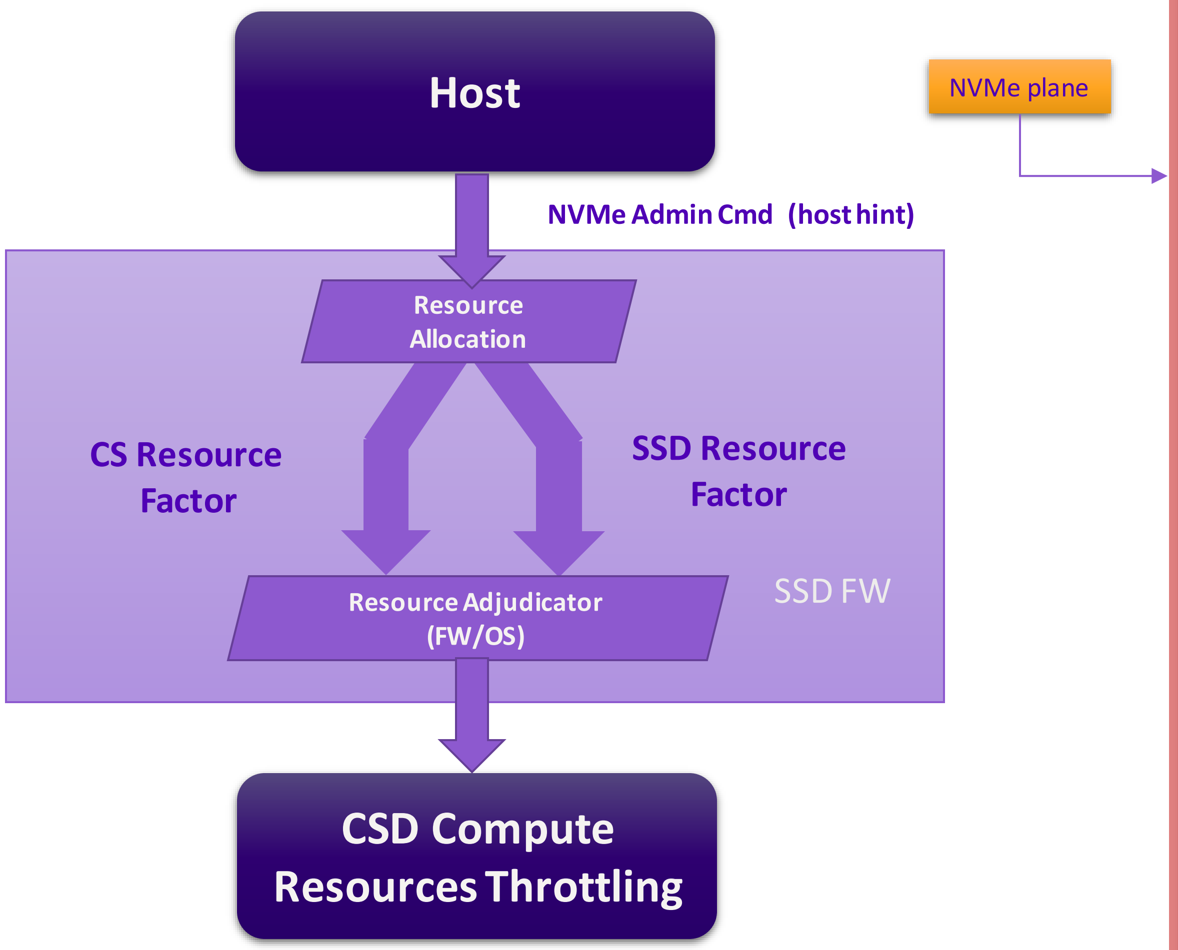
Modeling results indicate a high degree of scalability ideal for CPU offload*

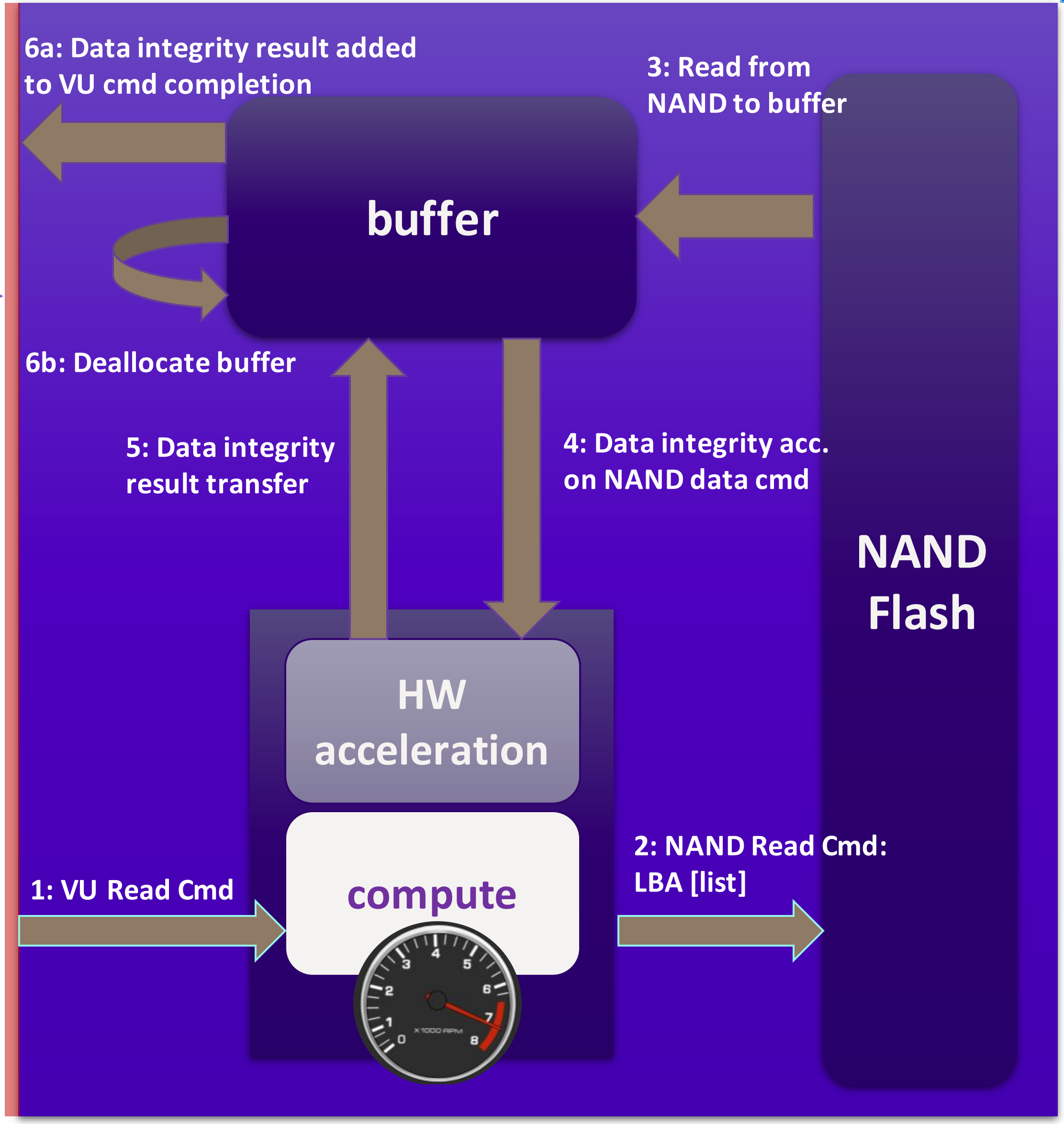
*Based on Solidigm's internal analysis. CSD theoretical performance based upon modeling.

Future Work

- Align with NVMe TP4091
  - Enhance implementation to leverage the Computational Programs Command Set
  - TP4091 commands can activate and execute the data integrity check
- Align with SNIA CS API
  - Leverage the SNIA CS API to standardize the user library
- Introduce dynamic resource allocation
  - Leverage existing FW architecture and CSD programming model

Dynamic Compute Resource Allocation





Conclusion

- Computational Storage is ideal for processing meta-data tasks on-drive
  - Utilizes existing HW accelerators and SW solutions, no ‘new’ work required
  - Operates on SHARDED data
    - **Major value add to customer’s concerns of data locality**
  - Scales across multiple CSDs
    - **Works independently, but brings overall increased performance to system**
    - Our PoC demonstrates linear scaling performance with additional drives

- This use-case is adaptable to the latest Computational Storage standards
  - Can become fully compliant with TP4091/4131 and Architectural and API specs
  - Does not restrict Host from using resources for other Computational work on drive