SQUEEZING COMPRESSION INTO SPDK

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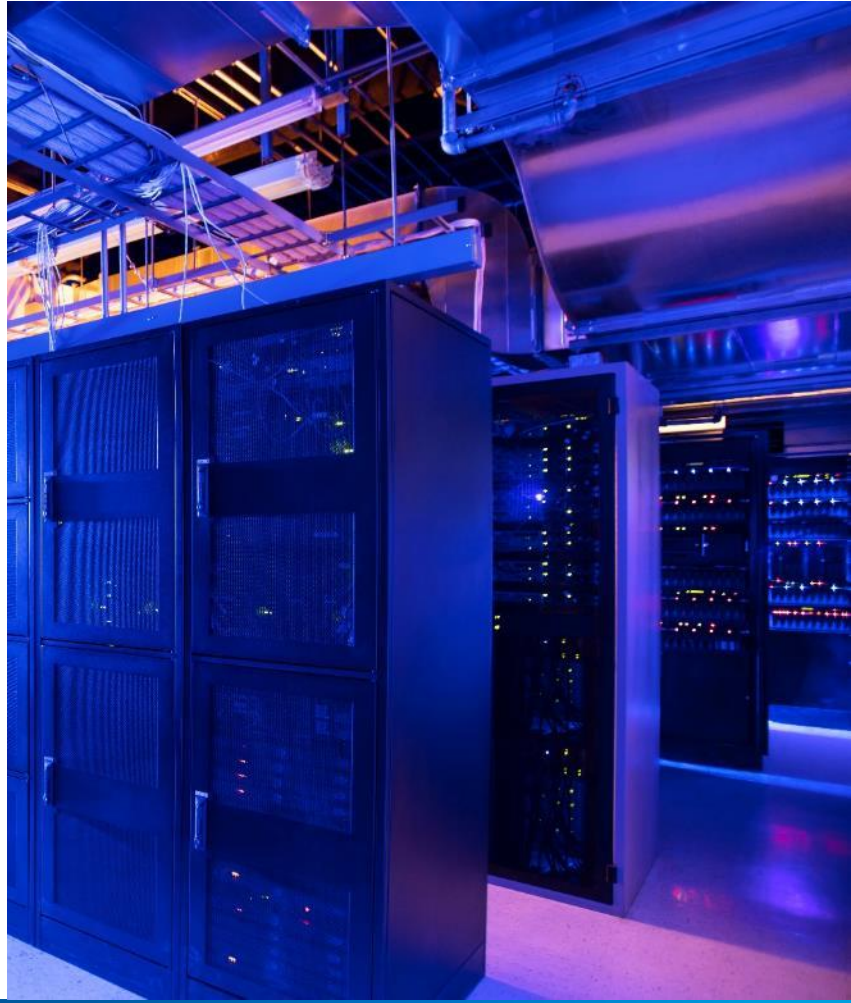
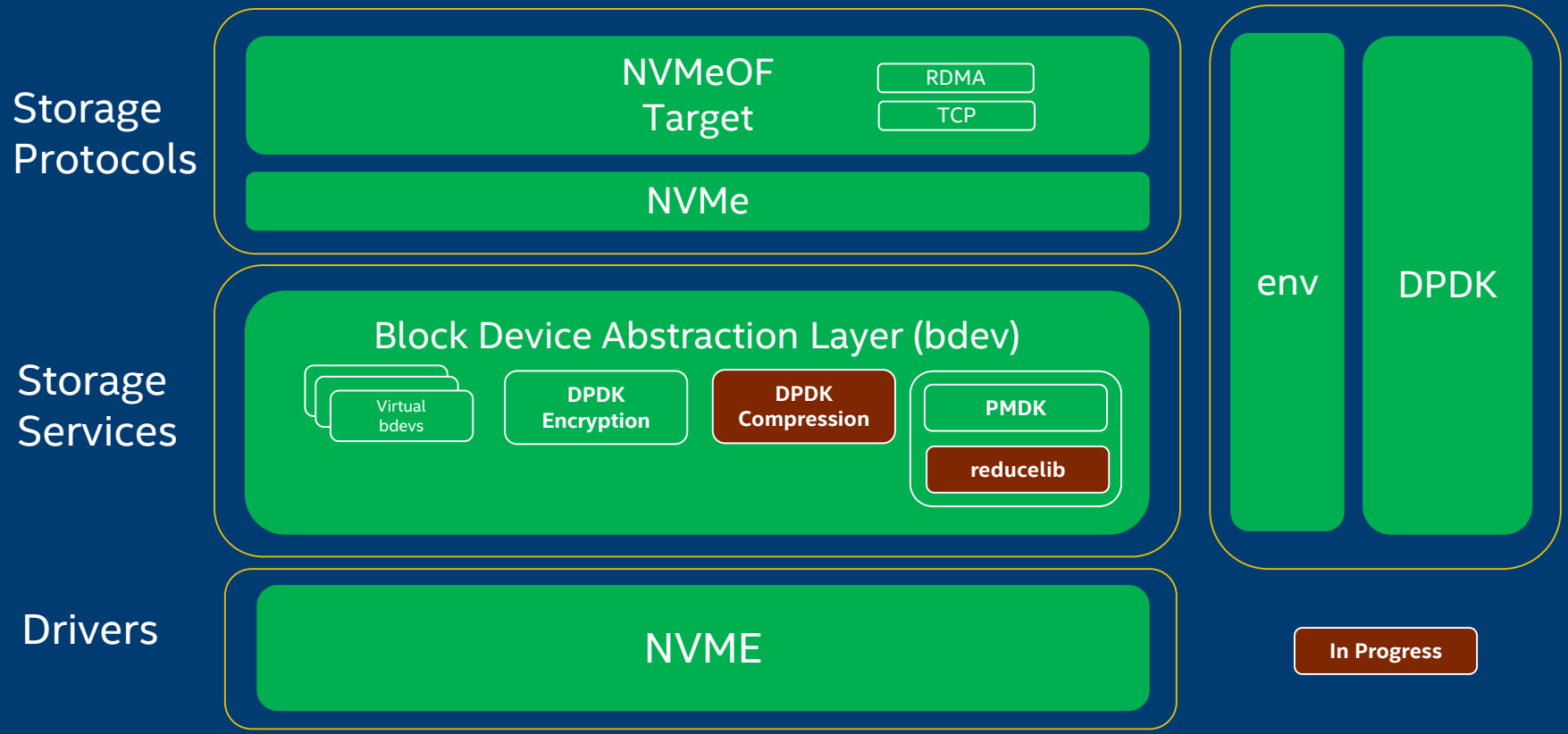
AGENDA

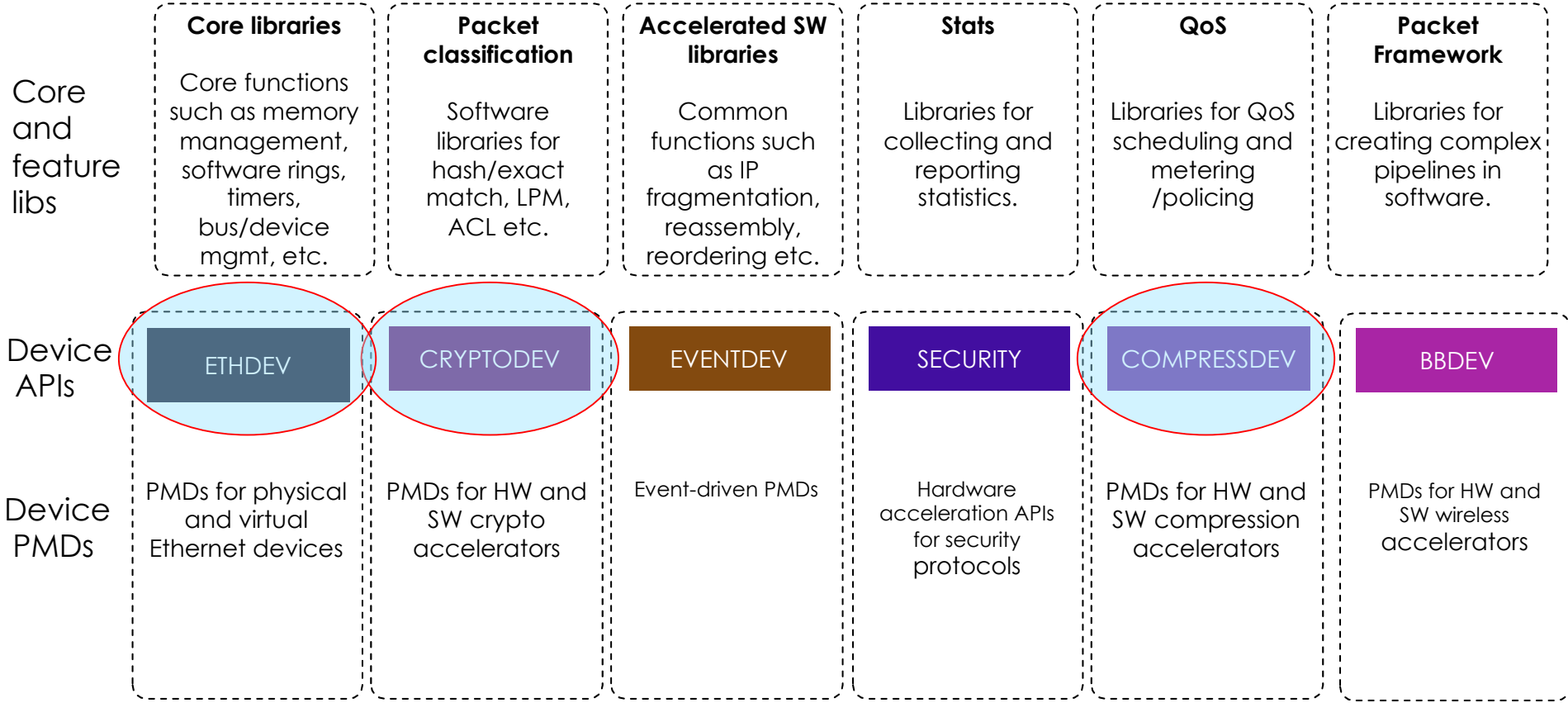
- High Level Architecture
- DPDK Library Overview
- Crypto Bdev Module
- Compression Bdev Module
- Introducing “reduce”



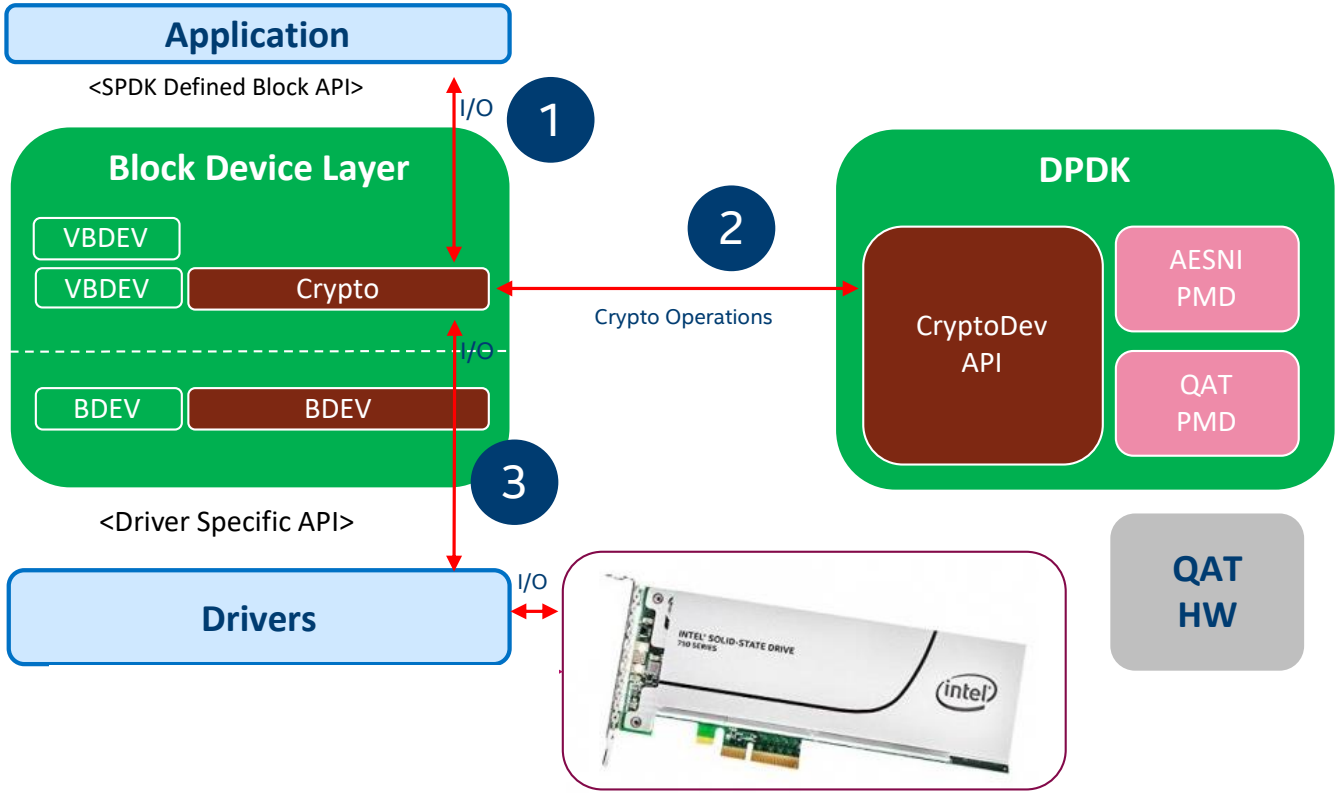
HIGH LEVEL ARCHITECTURE



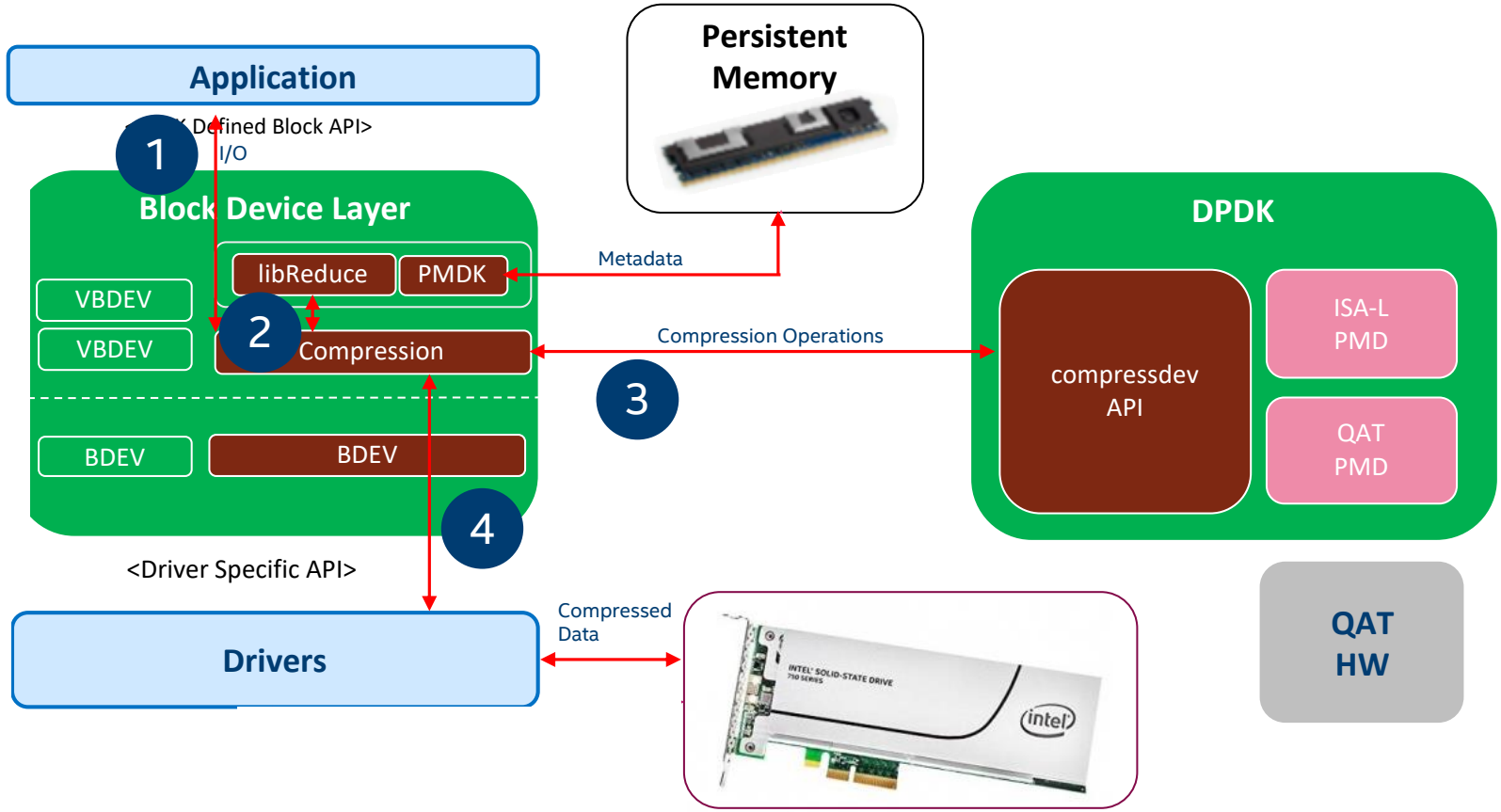
DPDK LIBRARIES



CRYPTO BDEV MODULE



COMPRESSION BDEV MODULE



LIBREDUCE OVERVIEW

Block device for backing I/O units

- Typically thin-provisioned SPDK logical volume

Persistent memory file for mapping metadata

- Uses PMDK directly for persistent memory access

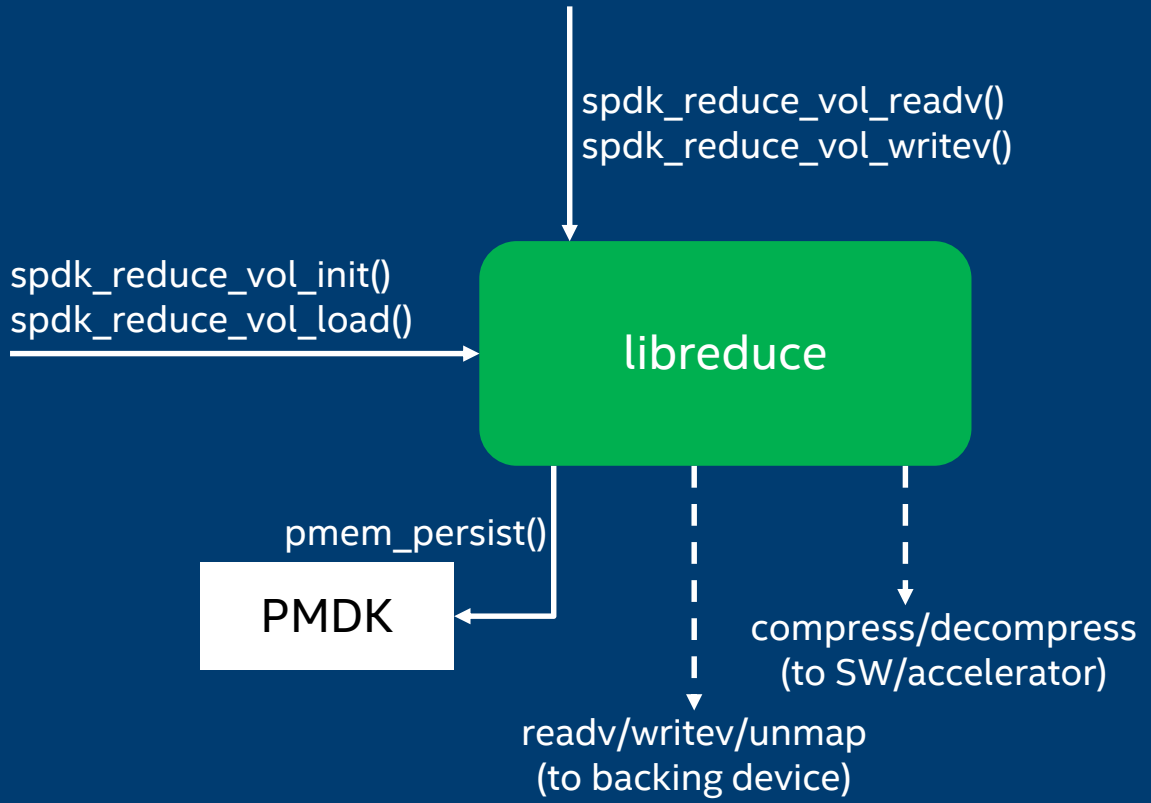
Metadata on block device

- Libreduce parameters
- Path to persistent memory file

Metadata algorithm only!

- Uses standard compression algorithms

INTEGRATION



Independent from SPDK framework and bdev layer

Caller ensures I/Os do not cross chunk boundary

Single-threaded
(per compression volume)

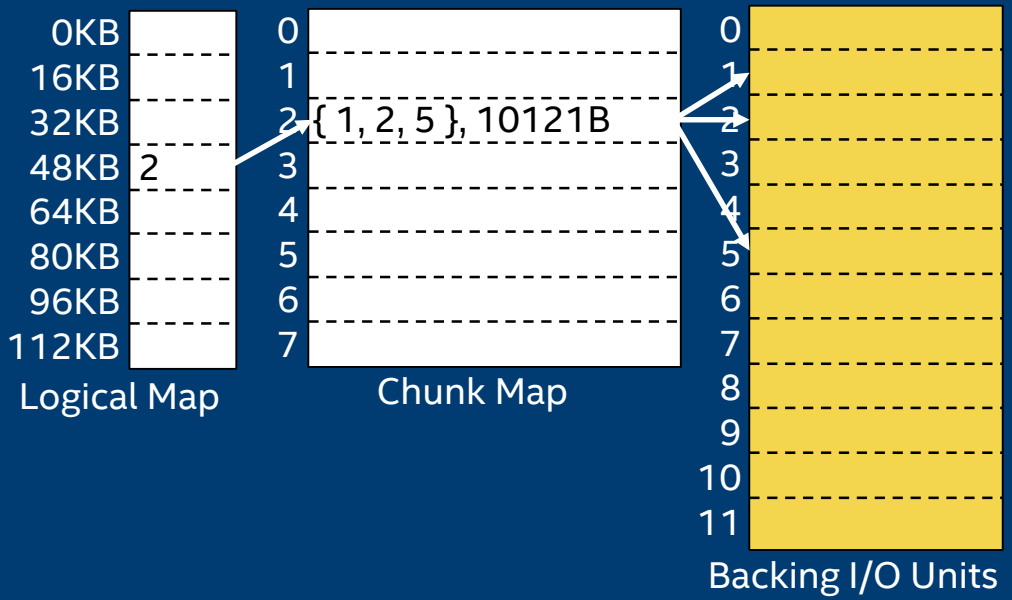
LAYOUTS

Backing Device

- Split into I/O units

Persistent Memory File

- Metadata based on chunks
- Chunk map contains chunk entries
- Chunk entry maps a logical chunk to its I/O units on disk
- Logical map contains logical map entries
- Logical map entries map a logical offset to its chunk entry



WRITE 4KB AT OFFSET 0KB

Persistent Memory

SSD

Logical Map: Lookup 0KB => empty

Allocate chunk entry in chunk map => 0

Compress chunk data

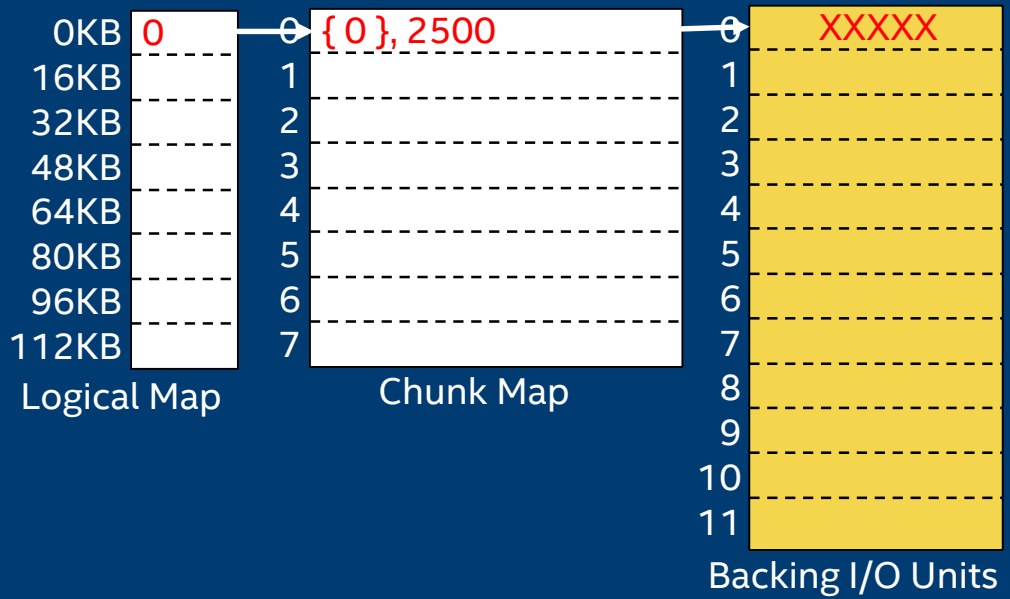
- 4KB user data + 12KB zeroes
- Compresses to 2500 bytes

Allocate 1 backing I/O unit => 0

Write compressed data to SSD

Write and persist chunk entry

Write and persist logical map entry



WRITE 16KB AT OFFSET 64KB

Persistent Memory

SSD

Logical Map: Lookup 16KB => empty

Allocate chunk entry in chunk map => 1

Compress chunk data

- 16KB user data
- Compresses to 14000 bytes

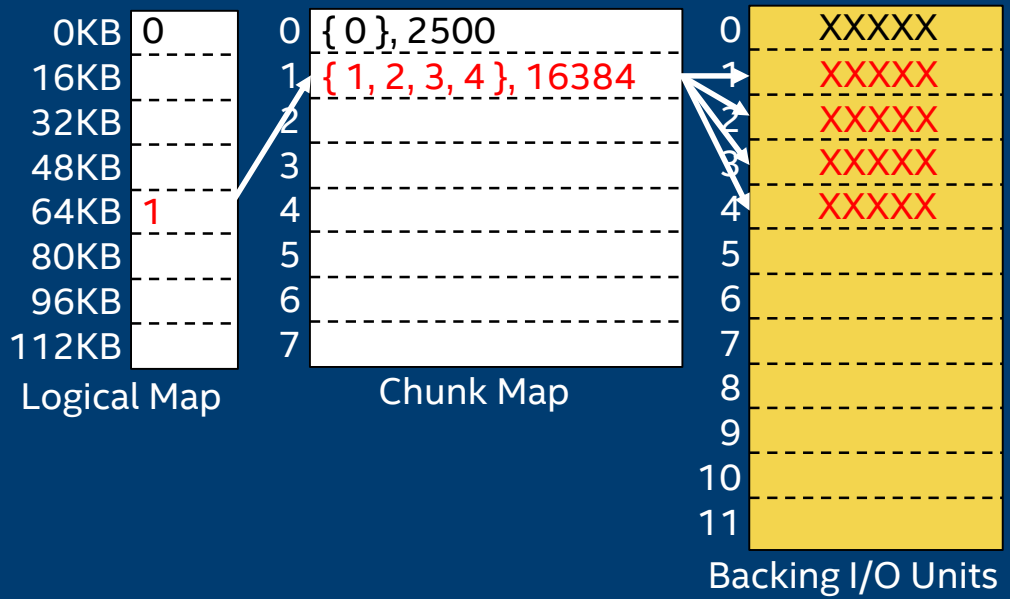
Allocate 4 backing I/O unit => 1, 2, 3, 4

Write uncompressed data to SSD

- 14000 bytes requires 4 4KB I/O units

Write and persist chunk entry

Write and persist logical map entry



WRITE 4KB AT OFFSET 4KB

Persistent Memory

SSD

Logical Map: Lookup 0KB => 0

Read I/O unit 0

Decompress 2500B => 16KB

Merge incoming 4KB

Allocate chunk entry in chunk map => 2

Compress chunk data => 5000B

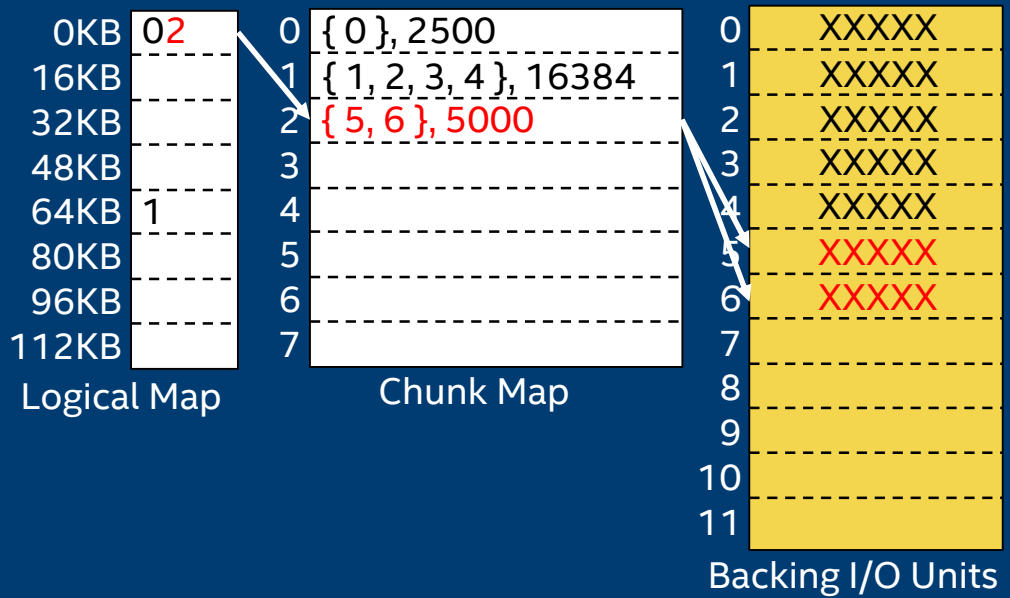
Allocate 2 backing I/O unit => 5, 6

Write compressed data to SSD

Write and persist chunk entry

Write and persist logical map entry

Release old chunk entry and I/O units

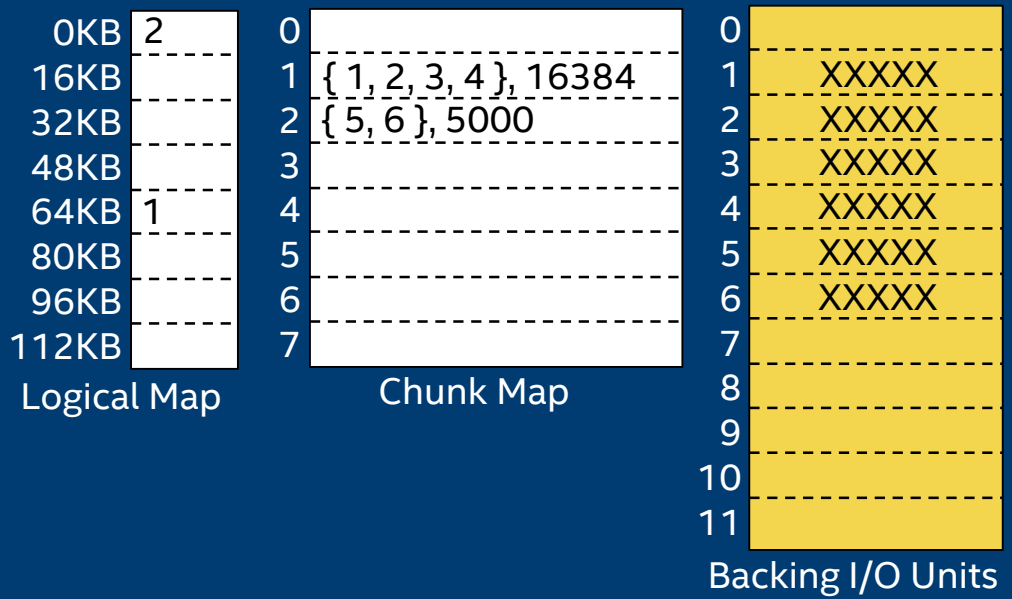


TRIM 16KB AT OFFSET 64KB

Logical Map: Lookup 64KB => 1

Clear and persist logical map entry

Release old chunk entry and I/O units



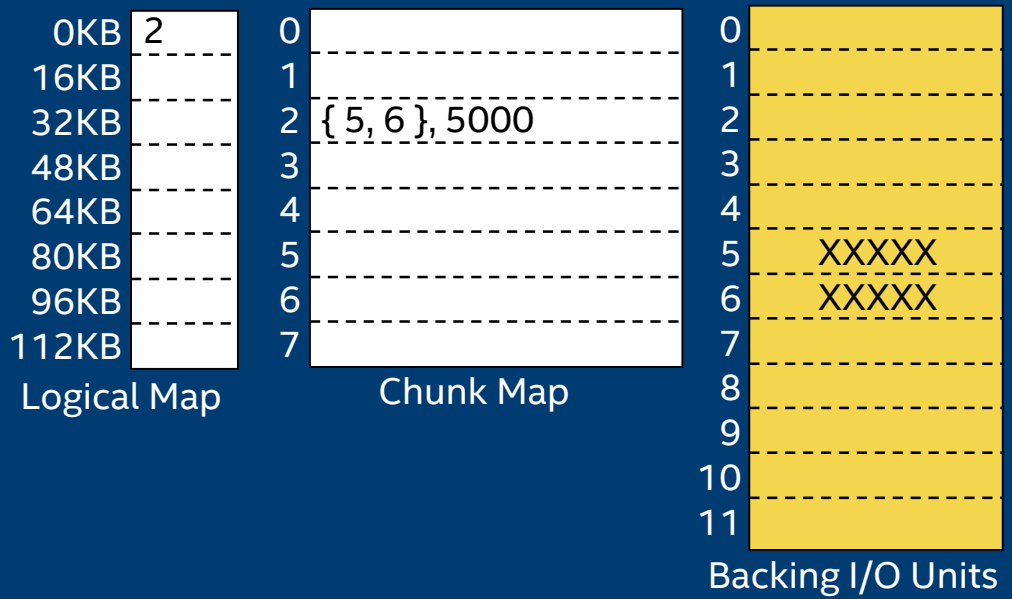
READ 4KB AT OFFSET 4KB

Logical Map: Lookup 0KB => 2

Read I/O units 5 and 6

Decompress 5000B => 16KB

- Target user buffer for 4KB
- Bit bucket for remaining 12KB



NEXT STEPS

Master branch has working init/load and read/write path

- Tested with PMDK backed by block device (not persistent memory)

spdk_reduce_vol_unmap

- With sub-chunk allocation masks

I/O path optimizations

Additional on-disk metadata parameters (i.e. compression algorithm)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