SDC 19

September 23-26, 2019
Santa Clara, CA

Squeezing Compression into SPDK

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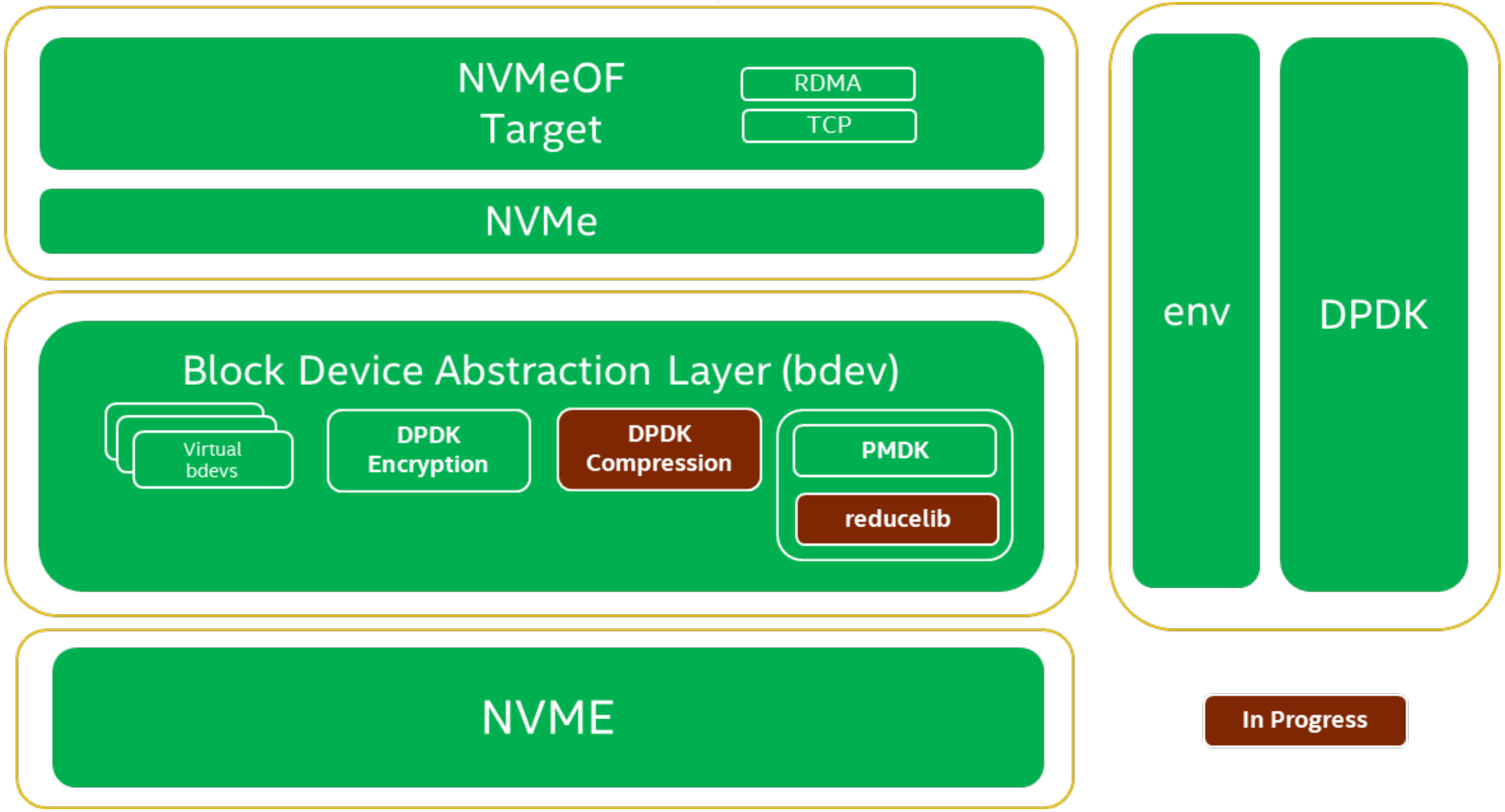
Agenda

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

High Level Architecture



DPDK Libraries

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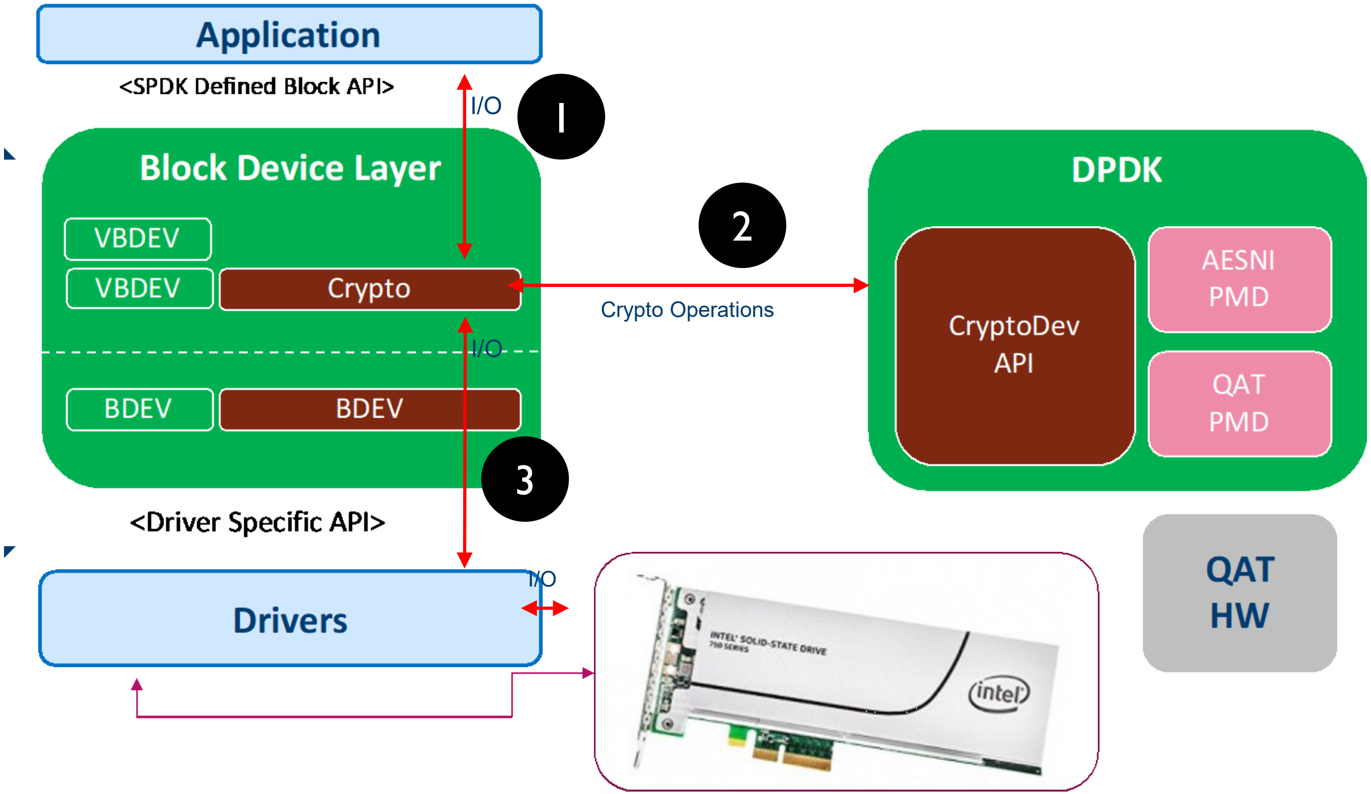
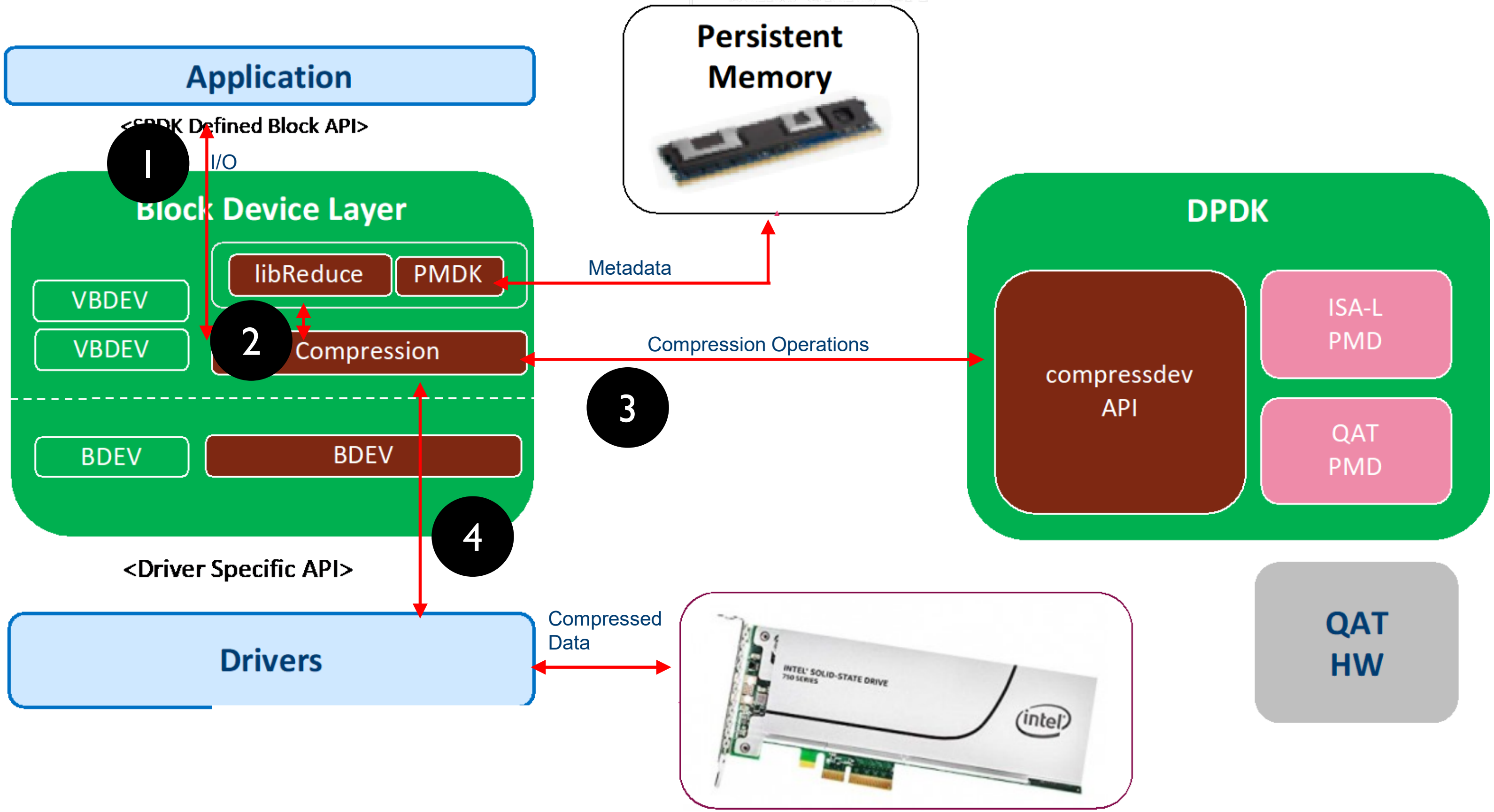
Core and feature libs	**Core libraries** Core functions such as memory management, software rings, timers, bus/device mgmt, etc.	**Packet classification** Software libraries for hash/exact match, LPM, ACL etc.	**Accelerated SW libraries** Common functions such as IP fragmentation, reassembly, reordering etc.	**Stats** Libraries for collecting and reporting statistics.	**QoS** Libraries for QoS scheduling and metering /policing	**Packet Framework** Libraries for creating complex pipelines in software.
Device APIs	ETHDEV	CRYPTODEV	EVENTDEV	SECURITY	COMPRESSDEV	BBDEV
Device PMDs	PMDs for physical and virtual Ethernet devices	PMDs for HW and SW crypto accelerators	Event-driven PMDs	Hardware acceleration APIs for security protocols	PMDs for HW and SW compression accelerators	PMDs for HW and SW wireless accelerators

Crypto Bdev Overview



Compression Bdev Overview



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Libreduce

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

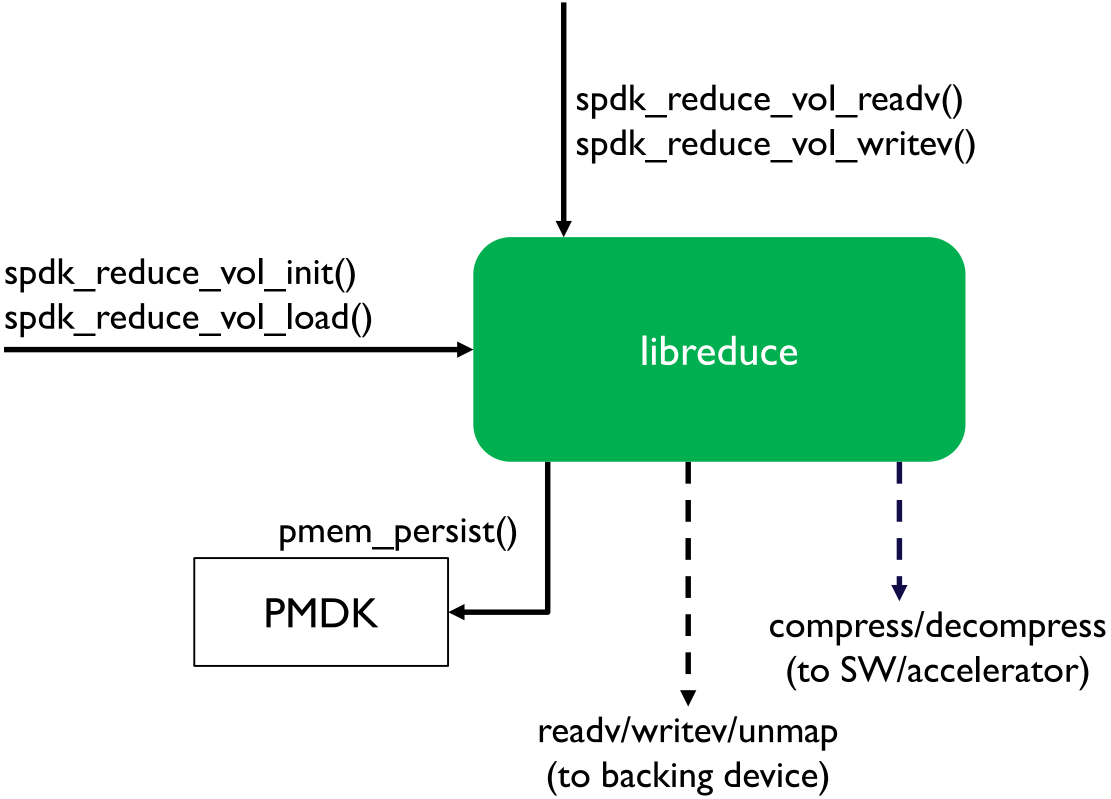
Metadata on block device

- 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

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Persistent Memory

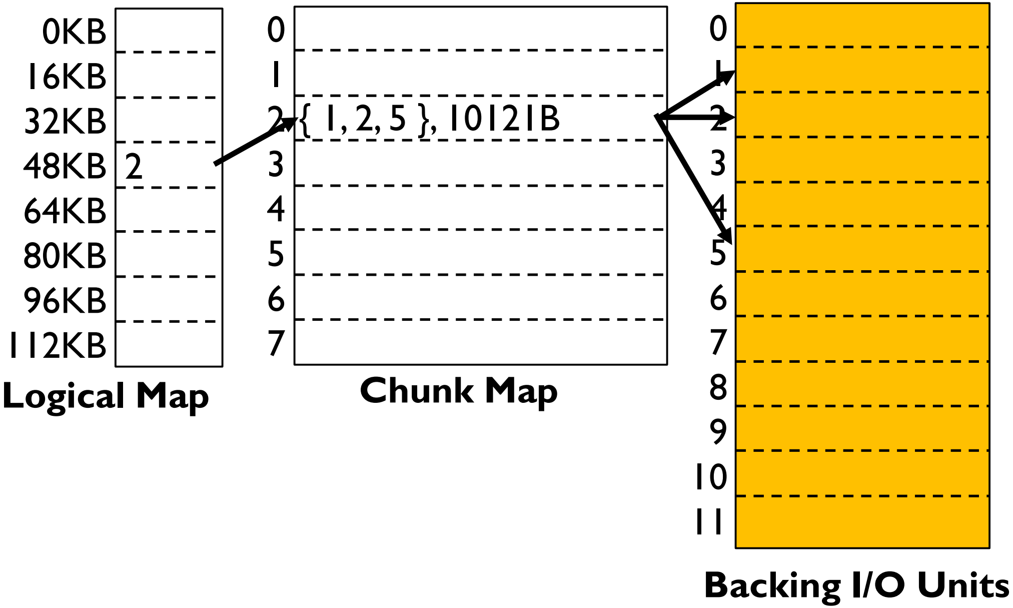
SSD

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 Offset 4KB at Offset 0KB

Persistent Memory

SSD

Logical Map: Lookup 0KB => empty

Allocate chunk entry in chunk map => 0

Compress chunk data

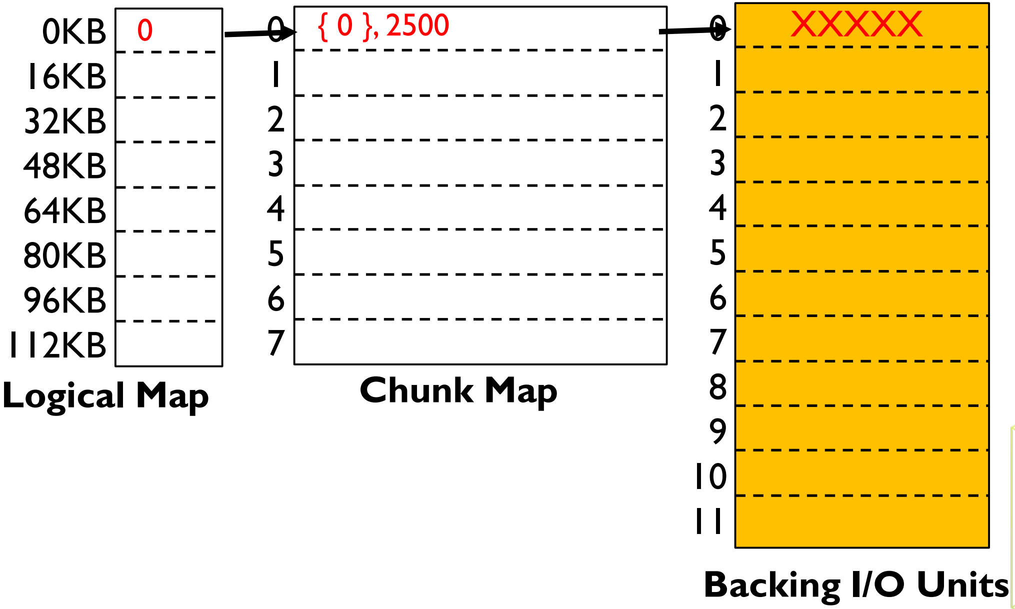
- 4KB user data + 12KB zeroes
- Compresses to 2500 bytes

Allocate 1 backing I/O unit => 0

Write compressed data to SSD

Write and persist chunk entry

Write and persist logical map entry



Write Offset 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

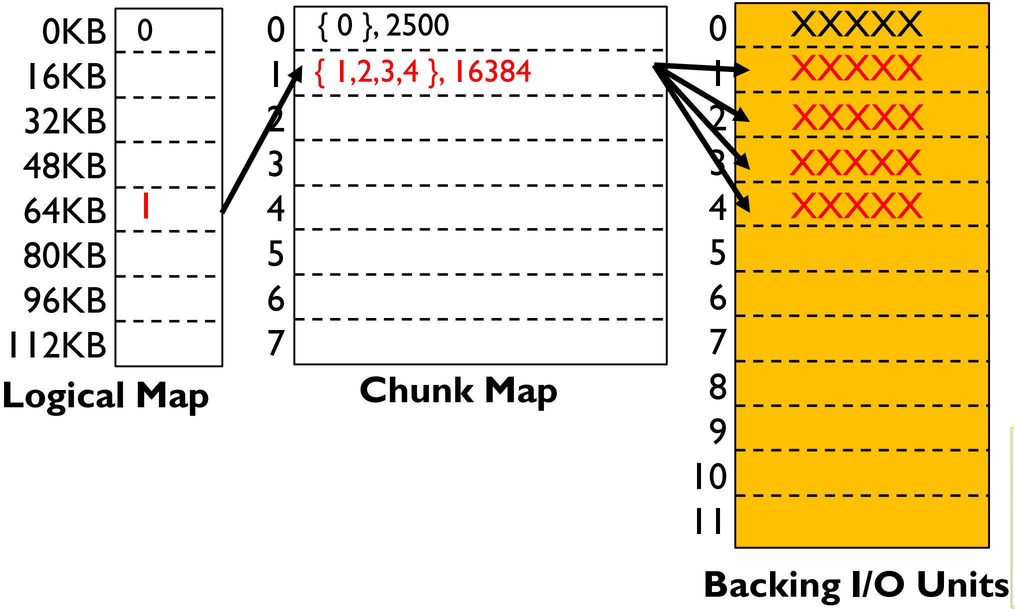
Allocate 4 backing I/O unit => 1, 2, 3, 4

Write uncompressed data to SSD

- 14000 bytes requires 4 4KB I/O units

Write and persist chunk entry

Write and persist logical map entry



Logical Map

0KB	0
16KB	
32KB	
48KB	
64KB	1
80KB	
96KB	
112KB	

Chunk Map

0	{ 0 }, 2500
1	{ 1,2,3,4 }, 16384
2	
3	
4	
5	
6	
7	

Backing I/O Units

0	XXXXX
1	XXXXX
2	XXXXX
3	XXXXX
4	XXXXX
5	
6	
7	
8	
9	
10	
11	

Write Offset 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

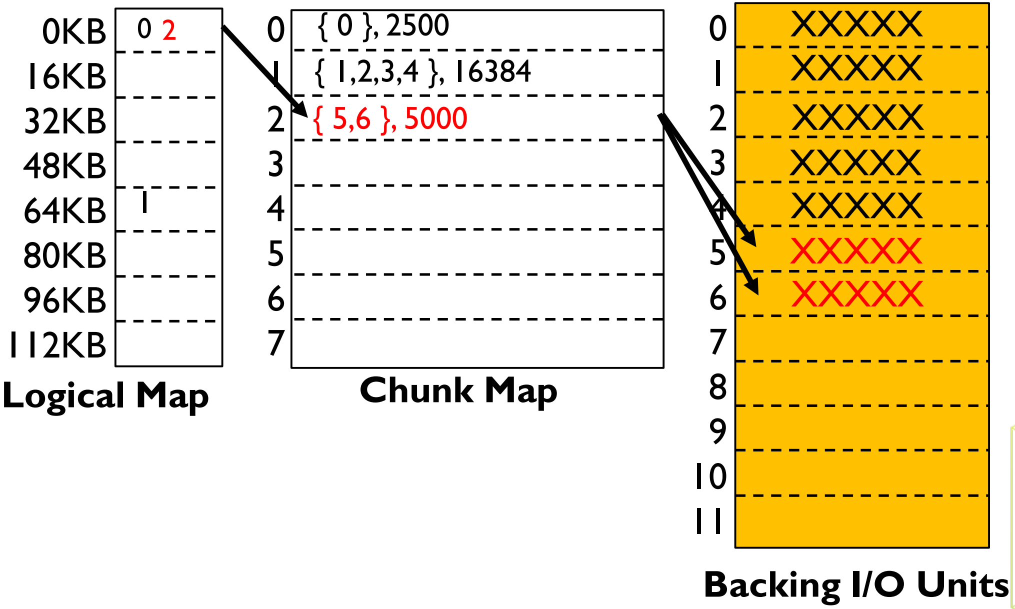
Allocate 2 backing I/O unit => 5, 6

Write compressed data to SSD

Write and persist chunk entry

Write and persist logical map entry

Release old chunk entry and I/O units



Logical Map

0KB	0 2
16KB	
32KB	
48KB	
64KB	1
80KB	
96KB	
112KB	

Chunk Map

0	{ 0 }, 2500
1	{ 1,2,3,4 }, 16384
2	{ 5,6 }, 5000
3	
4	
5	
6	
7	

Backing I/O Units

0	XXXXX
1	XXXXX
2	XXXXX
3	XXXXX
4	XXXXX
5	XXXXX
6	XXXXX
7	
8	
9	
10	
11	

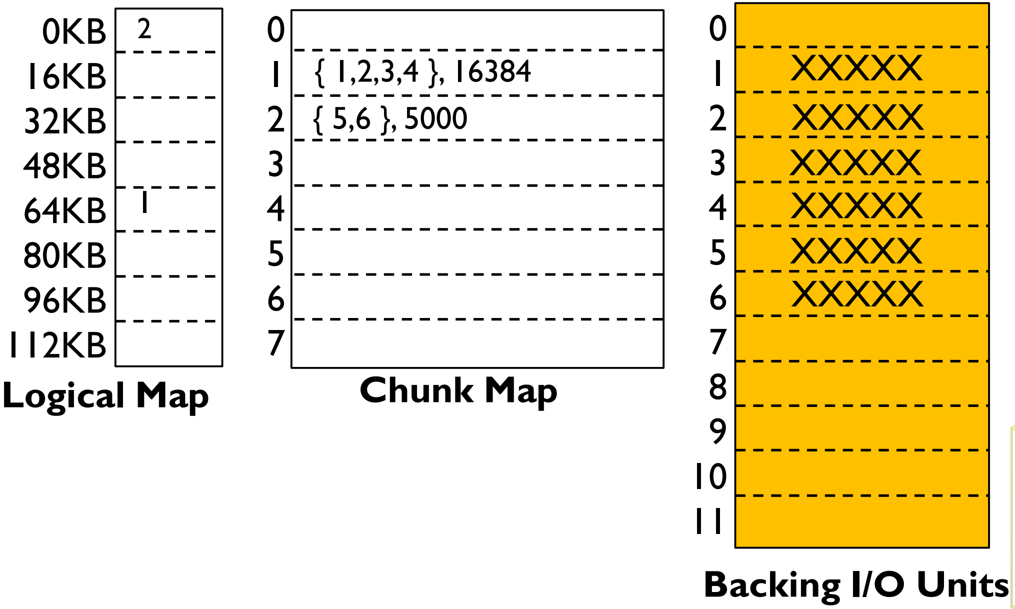
Trim 16KB at Offset 64KB

Persistent Memory
SSD

Logical Map: Lookup 64KB => 1

Clear and persist logical map entry

Release old chunk entry and I/O units



Logical Map

0KB	2
16KB	
32KB	
48KB	
64KB	1
80KB	
96KB	
112KB	

Chunk Map

0	
1	{ 1,2,3,4 }, 16384
2	{ 5,6 }, 5000
3	
4	
5	
6	
7	

Backing I/O Units

0	
1	XXXXX
2	XXXXX
3	XXXXX
4	XXXXX
5	XXXXX
6	XXXXX
7	
8	
9	
10	
11	

Read 4KB at Offset 4KB

Persistent Memory

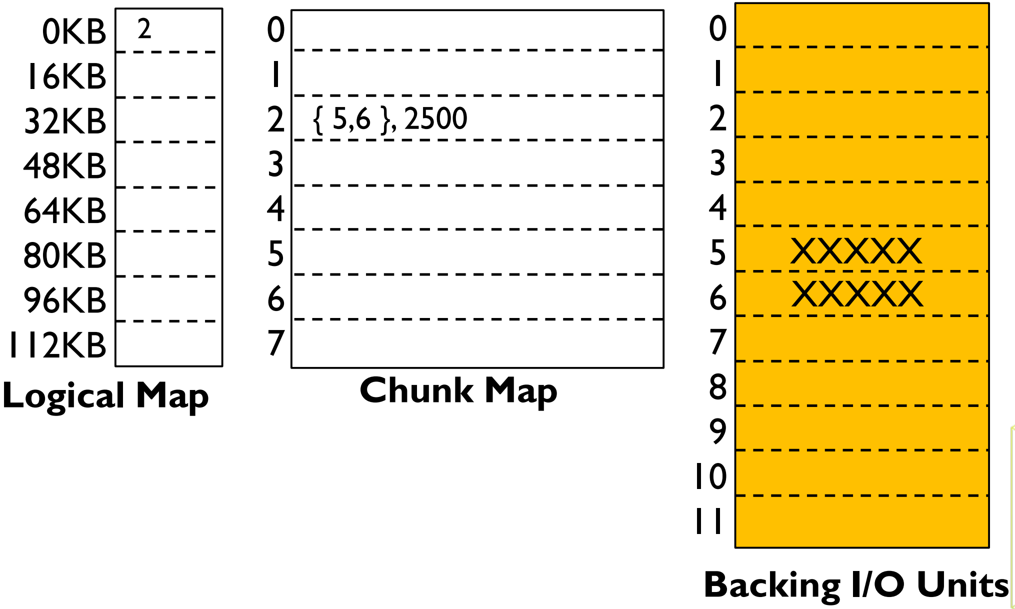
SSD

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

spdk_reduce_vol_unmap

- Sub-chunk allocation masks

Performance data with persistent memory!

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

Method for reduced metadata file size

- 32-bit io_unit/chunk indices (instead of 64-bit)

For More Information

- Main Website: https://spdk.io/
- Crypto & Compression vbdev Module Documentation: https://spdk.io/doc/bdev.html
- Libreduce Documentation: https://spdk.io/doc/reduce.html

Upcoming SPDK Developer Meetup:
https://spdk.io/news/2019/09/06/dev_meetup/