Week 11: RAID Disk Operation
CS5600 Spring, April 2025
Shorena K. Anzhilov

Question 1

We have following assumptions:

- RAID 0 with 5 disks
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- Stripe size = 2 sectors
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- Logical blocks are striped across disks in a round-robin fashion in chunks of 2 sectors per disk
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- Disk-local LBA is calculated based on how many strips have been written to each disk

a) write(LBA = 23, count = 7)

Writing 23 to 29:

- ☐ 23 (Volume LBA) – 1 (Disk) – 5 (Disk- local LBA)
- ☐ 24 (Volume LBA) – 2 (Disk) – 4 (Disk- local LBA)
- ☐ 25 (Volume LBA) – 2 (Disk) – 5 (Disk- local LBA)
- ☐ 26 (Volume LBA) – 3 (Disk) – 4 (Disk- local LBA)
- ☐ 27 (Volume LBA) – 3 (Disk) – 5 (Disk- local LBA)
- ☐ 28 (Volume LBA) – 4 (Disk) – 4 (Disk- local LBA)
- ☐ 29 (Volume LBA) – 4 (Disk) – 5 (Disk- local LBA)

Disk-level operations are as follows:

- ☐ write, disk1, LBA=5, len=1
- ☐ write, disk2, LBA=4, len=2
- ☐ write, disk3, LBA=4, len=2
- ☐ write, disk4, LBA=4, len=2

b) read(LBA = 14, count = 12)

Reading 14 to 25:

- ☐ 14 (Volume LBA) – 2 (Disk) – 2 (Disk- local LBA)
- ☐ 15 (Volume LBA) – 2 (Disk) – 3 (Disk- local LBA)
- ☐ 16 (Volume LBA) – 3 (Disk) – 2 (Disk- local LBA)
- ☐ 17 (Volume LBA) – 3 (Disk) – 3 (Disk- local LBA)

- ☐ 18 (Volume LBA) – 4 (Disk) – 2 (Disk- local LBA)
- ☐ 19 (Volume LBA) – 4 (Disk) – 3 (Disk- local LBA)
- ☐ 20 (Volume LBA) – 0 (Disk) – 4 (Disk- local LBA)
- ☐ 21 (Volume LBA) – 0 (Disk) – 5 (Disk- local LBA)
- ☐ 22 (Volume LBA) – 1 (Disk) – 4 (Disk- local LBA)
- ☐ 23 (Volume LBA) – 1 (Disk) – 5 (Disk- local LBA)
- ☐ 24 (Volume LBA) – 2 (Disk) – 4 (Disk- local LBA)
- ☐ 25 (Volume LBA) – 2 (Disk) – 5 (Disk- local LBA)

Disk-level operations are as follows:

- ☐ read, disk0, LBA=4, len=2
- ☐ read, disk1, LBA=4, len=2
- ☐ read, disk2, LBA=2, len=4
- ☐ read, disk3, LBA=2, len=2
- ☐ read, disk4, LBA=2, len=2

Question 2

We have follwng assumptions:

- ➢ RAID 4 with 5 disks (0–4), disk 4 is used for parity.
  - ○
- ➢ Stripe size = 2 sectors per disk.
  - ○
- ➢ Each stripe set includes 8 data sectors (disks 0–3), and 2 parity sectors (on disk 4).
  - ○
- ➢ Volume LBA layout is striped across disks 0–3; parity is on disk 4.

a. read(LBA = 3, length = 12)

Reading LBAs 3 – 14 (12 sectors).

- ☐ 3 (Volume LBA) – 1 (Disk) – 1 (Disk- local LBA)
- ☐ 4, 5 (Volume LBA) – 2 (Disk) – 0,1 (Disk- local LBA)
- ☐ 6, 7 (Volume LBA) – 3 (Disk) – 0,1 (Disk- local LBA)
- ☐ 8, 9 (Volume LBA) – 0 (Disk) – 2, 3 (Disk- local LBA)
- ☐ 10, 11 (Volume LBA) – 1 (Disk) – 2, 3 (Disk- local LBA)
- ☐ 12, 13 (Volume LBA) – 2 (Disk) – 2, 3 (Disk- local LBA)
- ☐ 14 (Volume LBA) – 3 (Disk) – 2 (Disk- local LBA)

Grouped disk reads as follows:

- ☐ read, disk1, LBA=1, len=3
- ☐ read, disk2, LBA=0, len=4
- ☐ read, disk3, LBA=0, len=3
- ☐ read, disk0, LBA=2, len=2

Party disk access is not needed unless a failure.

b. write(LBA = 3, length = 12)

Since this operation spans entire stripe sets, we use a Full-Stripe Write, which allows us to write both data and parity directly, no need to read old data or old parity.

LBAs 3 to 14 span 1.5 strip sets

Volume LBA to disk mapping:

- ☐ 3 (Volume LBA) – 1 (Disk) – 1 (Disk- local LBA)
- ☐ 4, 5 (Volume LBA) – 2 (Disk) – 0,1 (Disk- local LBA)
- ☐ 6, 7 (Volume LBA) – 3 (Disk) – 0,1 (Disk- local LBA)
- ☐ 8, 9 (Volume LBA) – 0 (Disk) – 2, 3 (Disk- local LBA)
- ☐ 10, 11 (Volume LBA) – 1 (Disk) – 2, 3 (Disk- local LBA)
- ☐ 12, 13 (Volume LBA) – 2 (Disk) – 2, 3 (Disk- local LBA)
- ☐ 14 (Volume LBA) – 3 (Disk) – 2 (Disk- local LBA)

Data Disk Writes:

- ☐ write, disk1, LBA=1, len=3
- ☐ write, disk2, LBA=0, len=4
- ☐ write, disk3, LBA=0, len=3
- ☐ write, disk0, LBA=2, len=2

Parity Disk (Disk 4):

Since this is full-stripe writes, we overwrite the parity blocks directly.

- ☐ write, disk4, LBA=1, len=2

Total write operations:

- ☐ write, disk0, LBA=2, len=2
- ☐ write, disk1, LBA=1, len=3
- ☐ write, disk2, LBA=0, len=4
- ☐ write, disk3, LBA=0, len=3
- ☐ write, disk4, LBA=1, len=2

c. write(LBA = 24, length = 8)

This write covers exactly one full stripe 8 sectors across 4 data disks.

Volume LBA to Disk Mapping:

- ☐ 24, 25 (Volume LBA) – 0 (Disk) – 6,7 (Disk- local LBA)
- ☐ 26, 27 (Volume LBA) – 1 (Disk) – 6,7 (Disk- local LBA)
- ☐ 28, 29 (Volume LBA) – 2 (Disk) – 6,7 (Disk- local LBA)
- ☐ 30, 31 (Volume LBA) – 3 (Disk) – 6,7 (Disk- local LBA)

Again since this is a full-stripe write, we can overwrite both data and parity directly without reading old data or parity.

Data Disk Writes:

- ☐ write, disk0, LBA=6, len=2
- ☐ write, disk1, LBA=6, len=2
- ☐ write, disk2, LBA=6, len=2
- ☐ write, disk3, LBA=6, len=2
- ☐ Parity Disk Write:
- ☐ write, disk4, LBA=6, len=1

Total Write Operations:

- ☐ write, disk0, LBA=6, len=2
- ☐ write, disk1, LBA=6, len=2
- ☐ write, disk2, LBA=6, len=2
- ☐ write, disk3, LBA=6, len=2
- ☐ write, disk4, LBA=6, len=1