Coding for SSD

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Contents

Details exist in each Chapters !

1. Structure of SSD

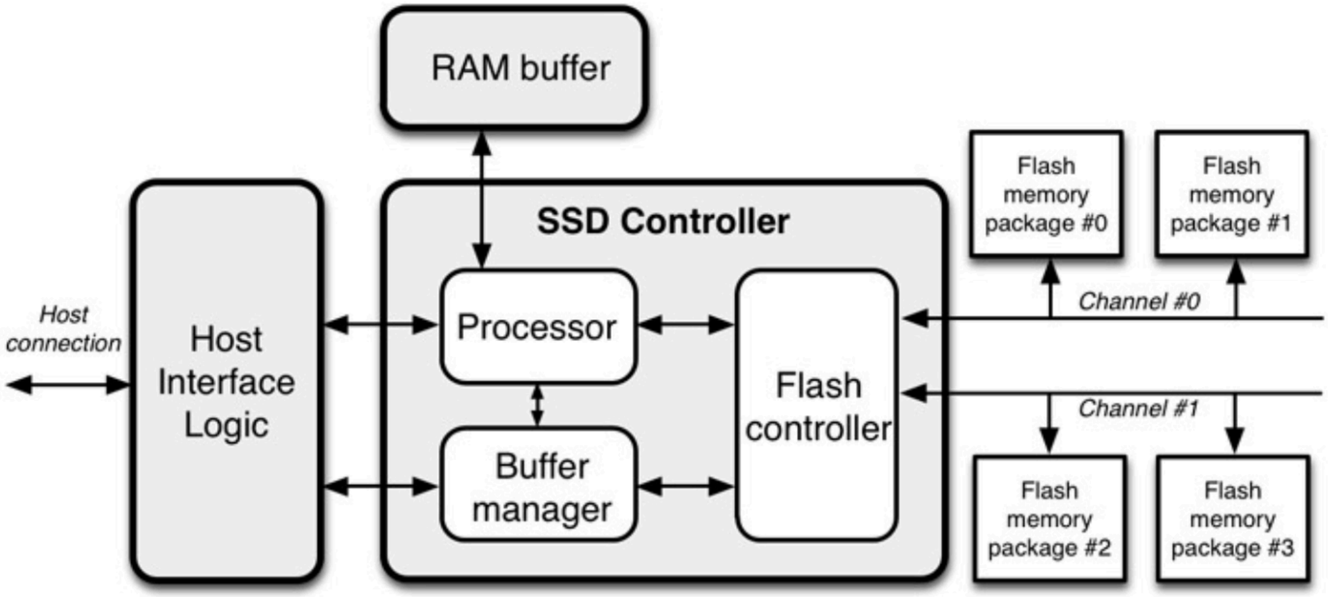
1.1 NAND Flash Memory

- As voltage applied to transistors, bit can be written or read
- remarkable property : life-cycle is **“wearing-off”**
- types of SSD Memory Cell : SLC, MLC, TLC

	SLC	MLC	TLC	HDD	RAM	L1 cache	L2 cache
P/E cycles	100k	10k	5k	*	*	*	*
Bits per cell	1	2	3	*	*	*	*
Seek latency (µs)	*	*	*	9000	*	*	*
Read latency (µs)	25	50	100	2000-7000	0.04-0.1	0.001	0.004
Write latency (µs)	250	900	1500	2000-7000	0.04-0.1	0.001	0.004
Erase latency (µs)	1500	3000	5000	*	*	*	*

1. Structure of SSD

1.2 Architecture of a solid-state drive



- Requests of user are inputted by host interface (SATA/PCIe)

- SSD has each RAM on themselves.

2. Operations

2.1. Read & Write & Erase

[Read]

- Reads are aligned on **page size**

[Write]

- Writes are aligned on **page size** -> causing Write Overhead
- Pages can’t be overwritten

[Erase]

- Erases are aligned on **block size**

2. Operations

2.2. Write examples

1. Initial configuration

Block 1000 (data)

PPN	data
0	x
1	y
2	z
3	

Block 2000 (free)

PPN	data
0	
1	
2	
3	

2. Writing a page

Block 1000 (data)

PPN	data
0	x
1	y
2	z
3	x'

Block 2000 (free)

PPN	data
0	
1	
2	
3	

3. Erasing a block (garbage collection)

Block 1000 (free)

PPN	data
0	
1	
2	
3	

Block 2000 (data)

PPN	data
1	y
2	z
3	x'

1. Init condition : block 2000 is free, block 1000 has three used pages (PPN = 0,1,2)

2. Writing a page : PPN = 0 page gets updated and becomes x’ and PPN = 0 page becomes “**stale**”, and new version of data is stored in a free page (PPN = 3)

3. Erasing a block : garbage collection process copies all the valid pages from the data block 1000 into the free block 2000, leaving behind the stale pages

2. Operations

2.3. Write amplification & Wear leveling

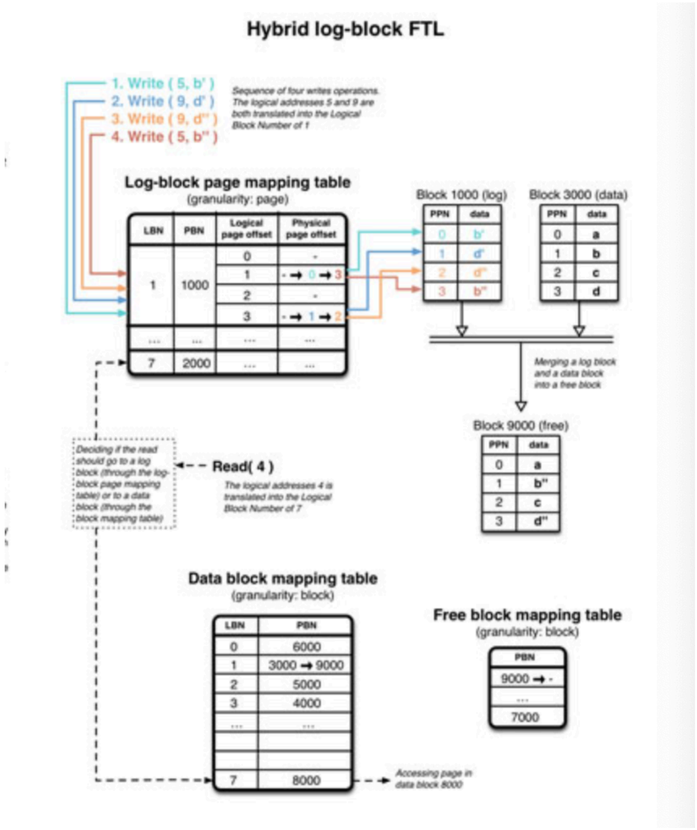
1. Write amplification

2. Wear leveling

3. FTL (Flash Translation Layer)

3.1 Logical block mapping

- It has a responsibility to convert LBA to PBA



3. FTL (Flash Translation Layer)

3.2. Garbage collection

- As it introduced, pages in SSD drive are not able to overwritten.

- Garbage collection is the process that helps stale pages to save new data by erasing ‘stale’ pages.

References

- 개발자를 위한 SSD https://tech.kakao.com/posts/328

- bigsyssw lab presentation : 개발자를 위한 SSD https://www.youtube.com/watch?v=4jn9oSyDPag