

1 Flash-Based SSDs

Vocabularies

1. Flash Solid-State Storage

- Is a type of non-volatile computer storage that stores and retrieves digital information using only electronic circuits, without any involvement of moving mechanical parts

2. NAND-Based Flash

- Is an electronic non-volatile computer memory storage medium using NAND-gate that can be electrically erased and reprogrammed.

3. Flash Page

- Is the smallest unit that can be programmed into flash

4. Flash Block

- Is a group of pages and the smallest unit that can be erased.

Physical Block Addresses											
Block 0						Block 1					
Page n	Page 1	Page 0	Page n	Page 1	Page 0	Page n	Page 1	Page 0	Page n	Page 1	Page 0
Sector 0	Sector 1	Sector n	Sector 0	Sector 1	Sector n	Sector 0	Sector 1	Sector n	Sector 0	Sector 1	Sector n



5. Wear Out

- Is similar to going past **expiration date**
- Means it has exceeded their endurance rating

6. Single-Level Cell

- Is a type of cell in solid-state storage that stores one bit of data per transistor (0 or 1)

7. Multi-Level Cell

- Is a type of cell in solid-state storage that stores two bits of data (i.e 00, 01, 10, 11) per cell using two different levels of charge

8. Triple-Level Cell

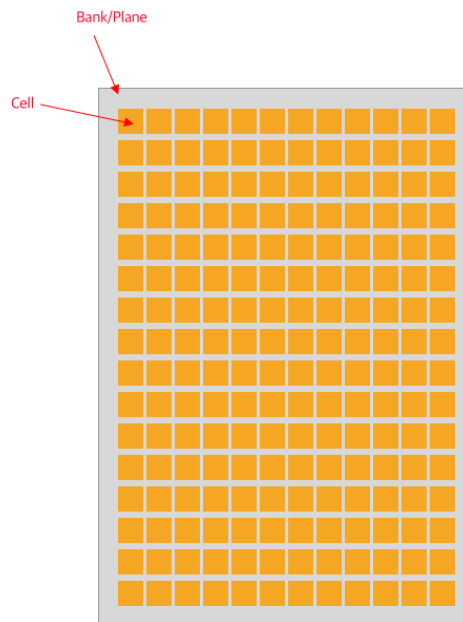
- Is a type of cell in solid-state storage that stores three bits of data per cell (i.e 000, 001, 010, 011, 100, 101, 110, 111)

9. Bank / Plane

- Is a group of large number of cells

10. Head Crash

- Is a condition where the drive head makes contact with the recording surface



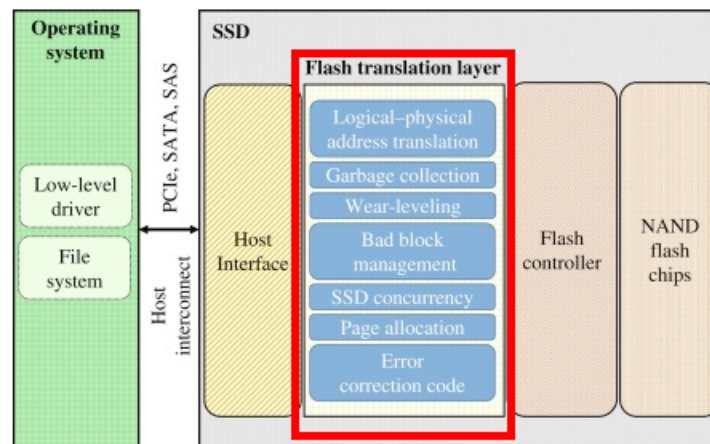
11. Disturbance

- Is also known as **read disturbance** or **program disturbance**

- Is a condition where accessing a bit in a page causes some bits to get flipped in neighboring pages

12. Flash Transition Layer

- Is an intermediate system made up software and hardware that manages SSD operations



13. Wear Leveling

- Is a technique for prolonging the service life of some kinds of erasable computer storage media, such as flash memory, which is used in solid-state drives (SSDs)

14. Direct Mapped

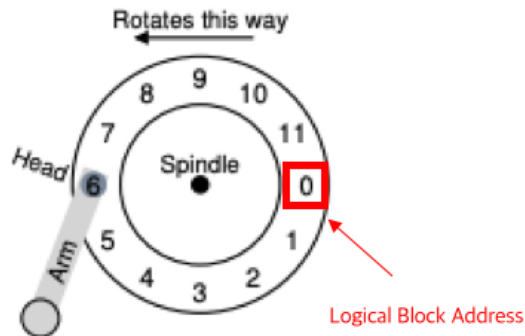
- Is a simplest organization of an **Flash Transition Layer** that maps read of logical page N directly to read of physical page N .

15. Logging

- Is a concept in **log-structured file system** that buffer all writes (data + metadata) using an in-memory segment; once the segment is full, write the segment to a log

16. Logical Block Address

- Is a common scheme used for specifying the location of blocks of data stored on computer storage devices, generally in secondary storage system



17. In-Memory Mapping Table

- Is a table inside the memory of the secondary storage device (is persistent in some form) that stores the physical address of each logical block in the system

18. Garbage Block

- Is also called **Dead Block**
- Is old version of block in secondary storage, such as solid state drive

19. Garbage Collection

- Is the process of finding garbage blocks and reclaiming them for future use

20. Cache Flush

- Is the process of clearing out sections of memory to ensure writes have actually been persisted in solid state drive

21. Trim

- Is an operation that takes an address (and possibly a length) and informs the device that the block(s) specified by the address (and length) have been deleted



22. Overprovision

- Is an extra amount of flash space used to reduce the cost of **garbage collection**, increase the longevity of flash drive, and prevents the device from slowing down



23. Page-Level FTL

- Is an intermediate system made of software and hardware that manages SSD operations at page-level.
 - It does not write a full block
 - Only writes the necessary page(s) of data along with the FTL metadata that must be written to track of the new position of the data

24. Hybrid Mapping

- Is a mapping technique used in **Flash Transition Layer** that utilizes both block-based mapping and page-based mapping to enable flexible writing but also reduce mapping costs

25. Log Blocks

- Are blocks in solid state storage where contents are erased and all writes are directed

26. Switch Merge

- This will be revisited when reading related section

27. Partial Merge

- This will be revisited when reading related section

28. Full Merge

- This will be revisited when reading related section

1.1 Flash-Based SSDs

- Has two interesting problems to overcome
 1. To write a small chunk (called **flash page**), a bigger chunk (**flash block**) must be erased first
 2. Writing too often would cause a page to **wear out**

1.2 Storing a Single Bit

- **Single-level cell** → 1 bit per cell
- **Multi-level cell** → 2 bits per cell
- **Triple-level cell** → 3 bits per cell
- **Single-level cell** has higher performance and are more expensive
 - More 촌촌하다
- How SLC, MLC, TLC works → Physics!!

1.3 From Bits to Banks / Planes

Question Is content in a flash chip a cell? How many bits can be stored per content?

Question I should ask clarification from professor about why Samsung and other tech giants are producing higher level cells if SLC is better in performance

- In each plane/bank, there are large number of blocks
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- 1.4 Basic Flash Operations
- 1.5 From Raw Flash to Flash-Based SSDs
- 1.6 FTL Organization: A Bad Approach
- 1.7 A Log Structured FTL
- 1.8 Garbage Collection
- 1.9 Mapping Table Size
- 1.10 Hybrid Mapping
- 1.11 Wear Leveling
- 1.12 SSD Performance And Cost