

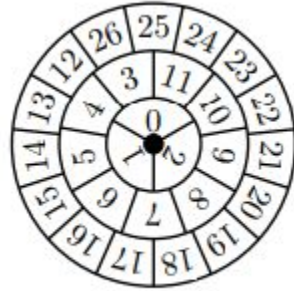
# Storage & File Systems

# Storage Device

- Is  $n$  pages with address space  $0\dots n-1$ .
- OS interface to read/write a page(s) with the given address(es).
- Examples: HDD, SSD, tapes, etc.

# HDD

- Magnetic platters rotating on a spindle, read/write head per platter.
- Data stored on the platter surface in tracks and sectors/pages.



$$T_{I/O} = \underbrace{T_{seek} + T_{rotation}}_{T_{positioning}} + T_{transfer}$$

$$R_{I/O} = \frac{\text{size of } A}{T_{I/O}}$$

# HDD Scheduling

- First Come First Serve (FCFS)
- Shortest Seek Time First (SSTF)
- Shortest Positioning Time First (SPTF)
- Elevator (SCAN)
- C-SCAN
- F-SCAN

# SSD

- Data organized into blocks, that consist of pages.

Block	0				1			
Page	0	1	2	3	4	5	6	7
Content	<i>a'</i>			<i>a</i>				
State	v	e	e	i	e	e	e	e

- Page can be valid (v), invalid (i), or erased (e).
- Only erased pages can be written, and become valid.
- To erase a page, the containing block must be erased.
- A page becomes invalid if updated by writing it to a different page.

# SSD

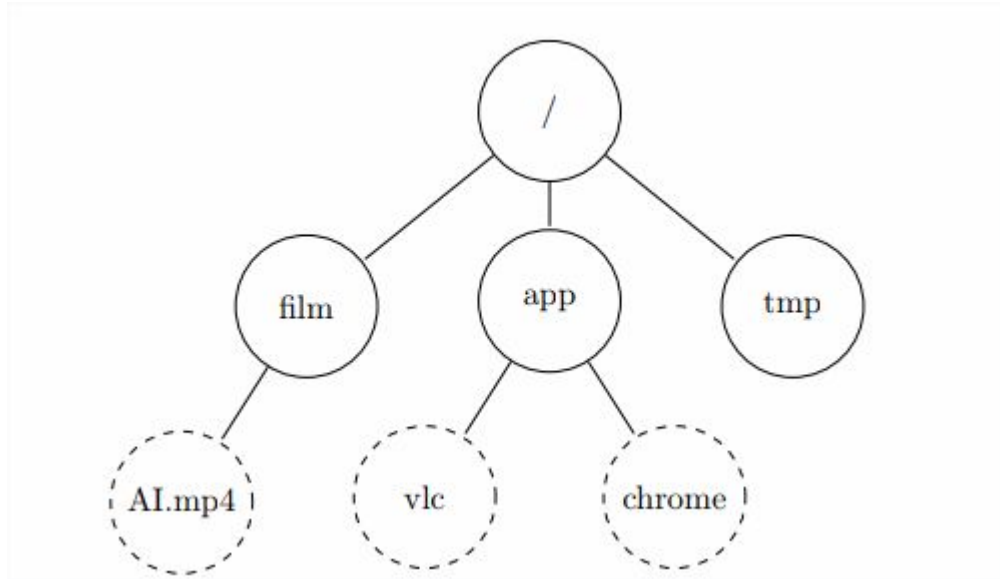
- Flash Translation Layer (FTL) stores
  - State of each page
  - Mapping of logical page addresses to physical page addresses

FTL

Table	0 → 0, 1 → 1, 2 → 5, ..., 8 → 11											
Block	0				1				2			
Page	0	1	2	3	4	5	6	7	8	9	10	11
Content	0	1	2	3	4	2	3	4	5	6	7	8
State	v	v	i	i	i	v	v	v	v	v	v	v

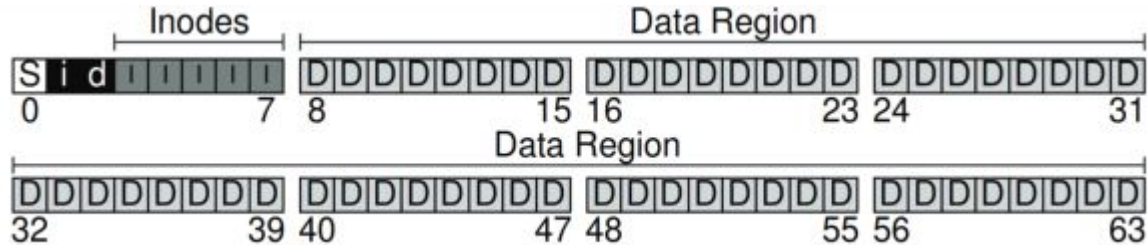
# Logical File System

- Is a Directory Tree



# A Physical File System

- Device pages grouped into blocks.
- Each file (or directory) has a unique inode.
- The inode contains
  - File metadata such as owner, access permissions, etc.
  - Direct or indirect pointers to blocks containing the file data.
- Superblock (root inode, etc.), inode and data bitmaps and regions





# Virtual File System

- Physical file system accessed by mounting it to a directory.
- POSIX permissions
  - Are assigned to a user, group of users, and everyone else.
  - Every file has a owner and a group owner.
  - File access controlled by defining rwx permissions of owner, group owner, others.