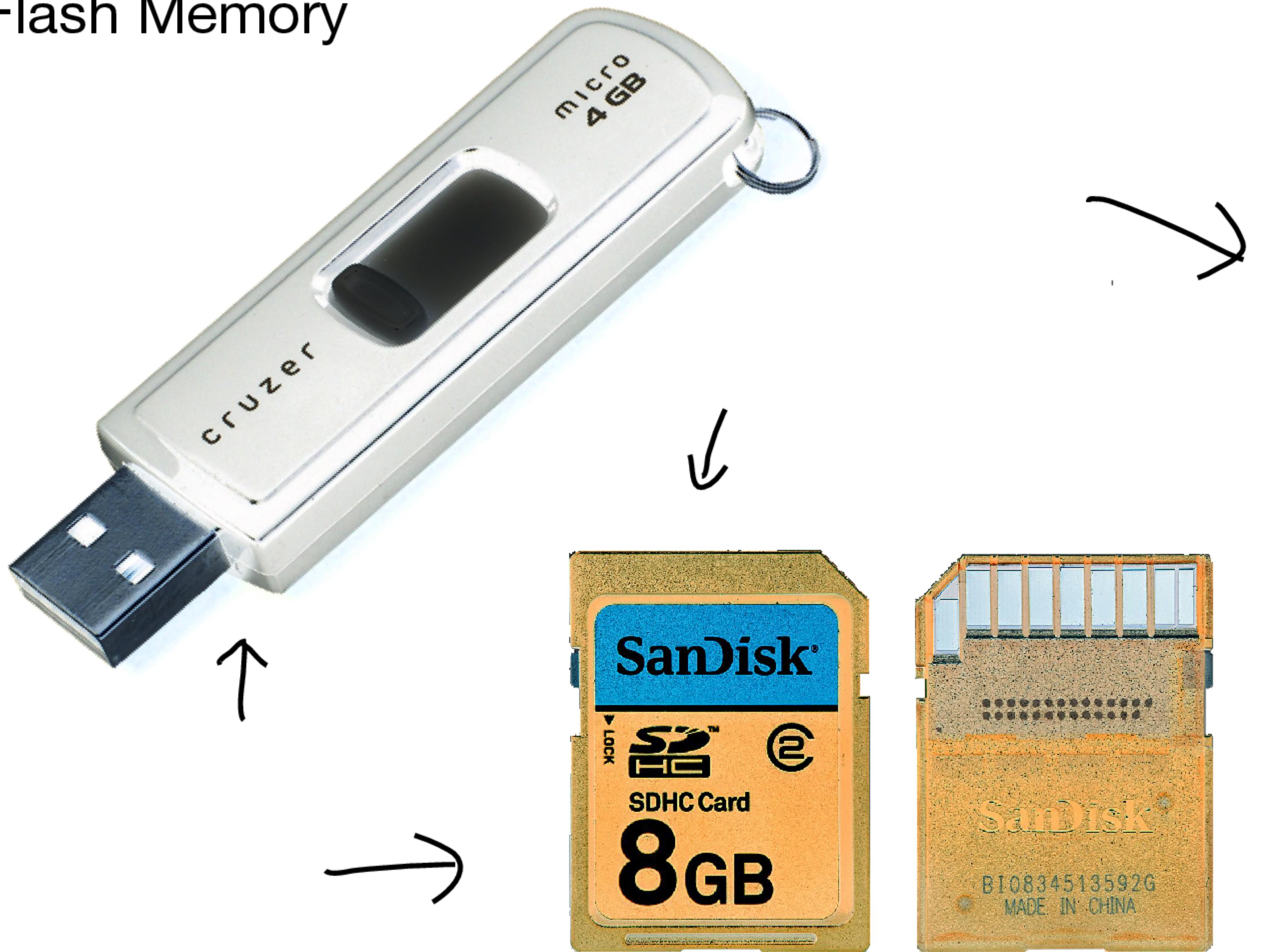
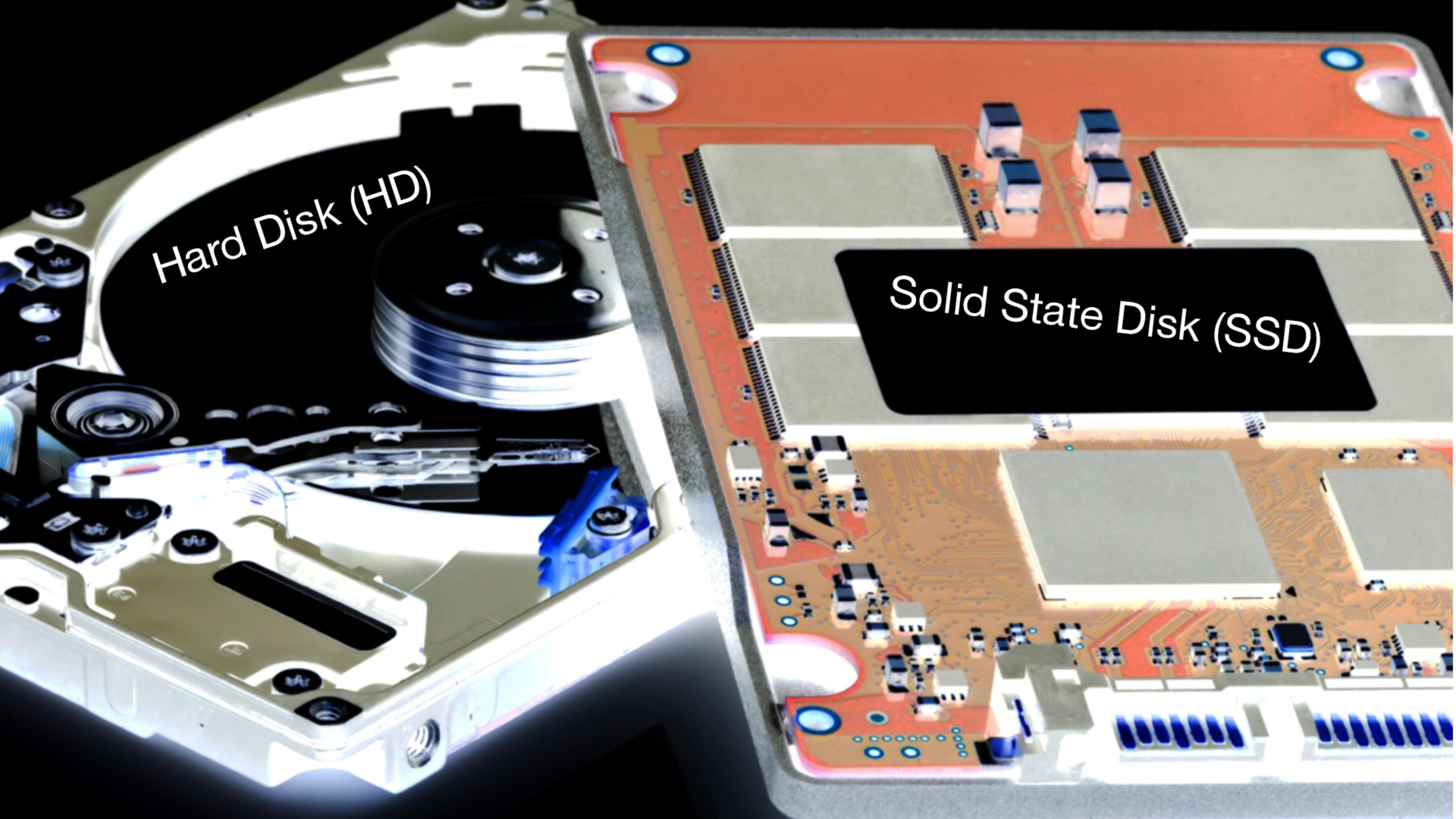




# Flash Memory





Hard Disk (HD)

Solid State Disk (SSD)

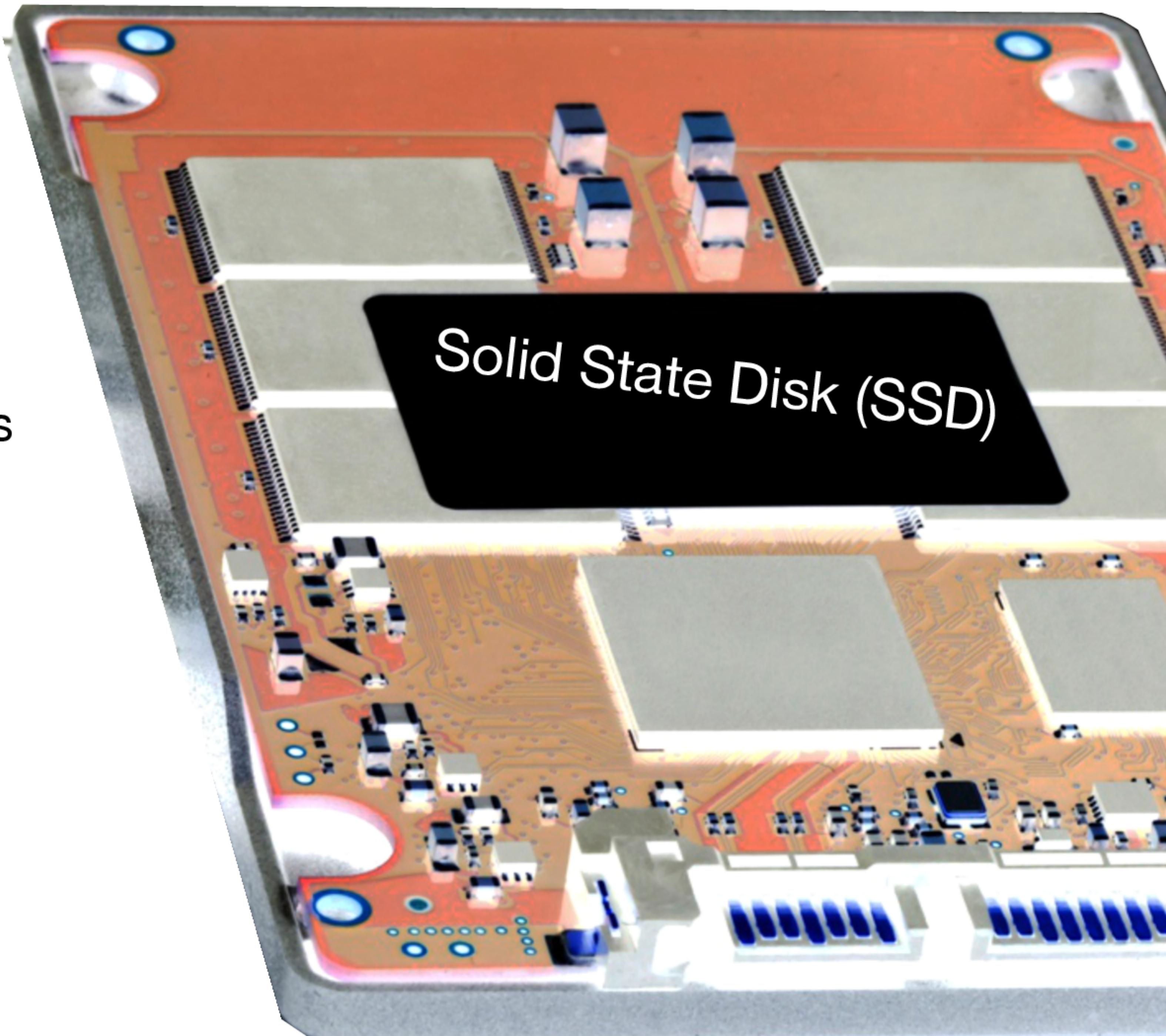
# Major Properties

non-volatile

robust, no moving parts

~100x faster random access

plus: parallel accesses



# Blocks vs Superblocks

block := 8KB

**superblock** := set of blocks

# Super Block

0	1	2	3	4	5	6	7	8
16	17	...						

0	1	2	3	4	5	6	7	8
16	17	...						

# Blocks vs Superblocks

block := 8KB

**superblock** := set of blocks

can only write to **empty**, freshly erased blocks

erase happens at the level of  
superblocks, **not blocks**

0	1	2	3	4	5	6	7	8
16	17	...						

0	1	2	3	4	5	6	7	8
16	17	...						

# Example: Writing a Block

5131

SB 2

- ① erase superblock
  - ② write block

# Writing a Block

if empty block available:

    write data to block

else:

    possibly reshuffle/garbage collect

    erase superblock

    write data to block

# Write Amplification

$$\text{write amplification} = \frac{\text{data physically written}}{\text{data logically written}} \geq 1$$

factors in:

~~super~~ block erasure

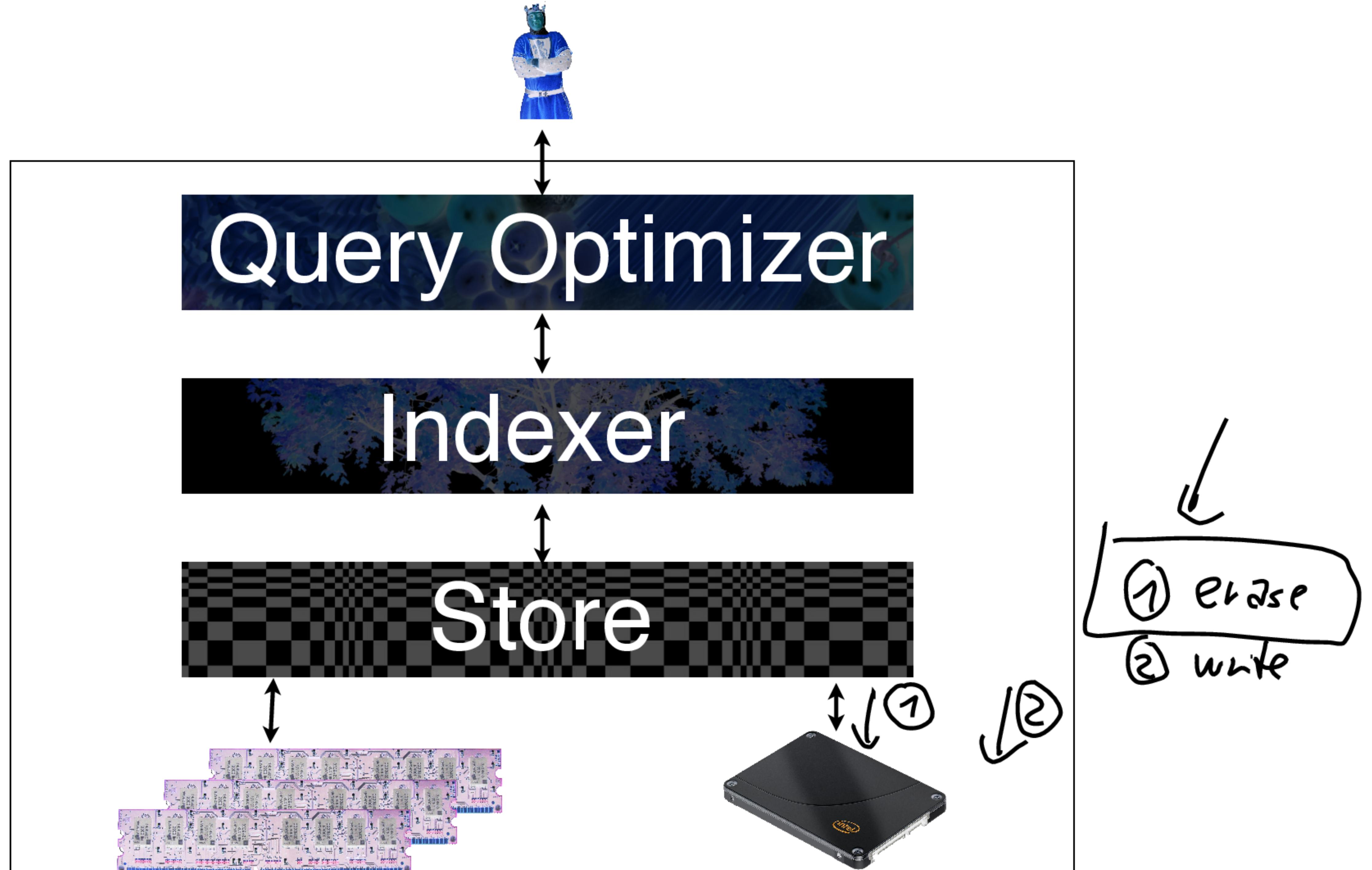
garbage collection

wear leveling costs

internal RAID

↑  
8K { }

Trim



# SSD Controller

similar tasks as the HD controller:

mapping of logical addresses to physical addresses

caching (128-512 MB)

$\text{flush}() \rightarrow \text{flush}$

# SSD Controller

similar tasks as the HD controller:

- mapping of logical addresses to physical addresses

- caching (128-512 MB)

- remapping of erroneous blocks

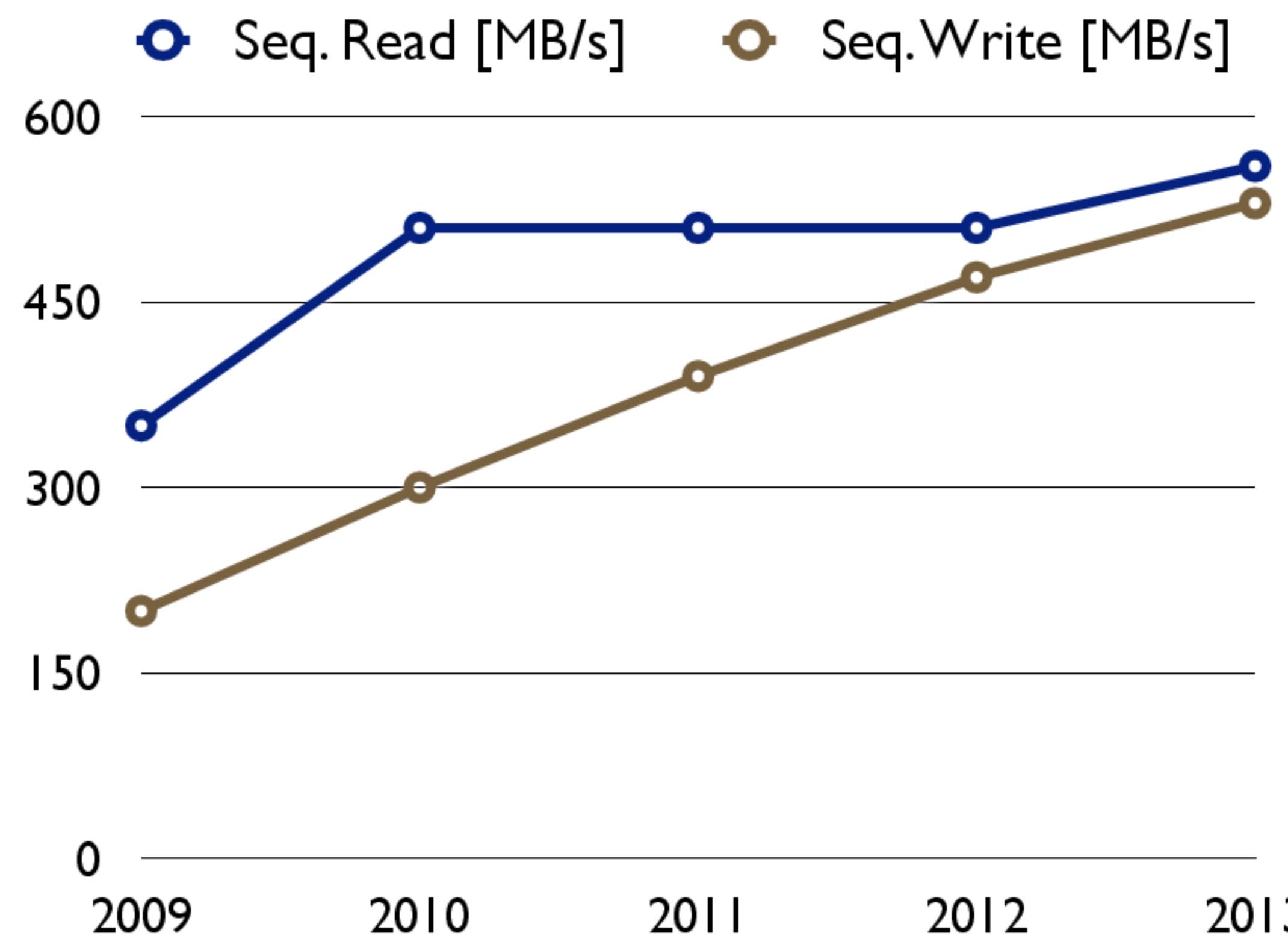
in addition:

- RAID-like storage of data cross different chips in the drive

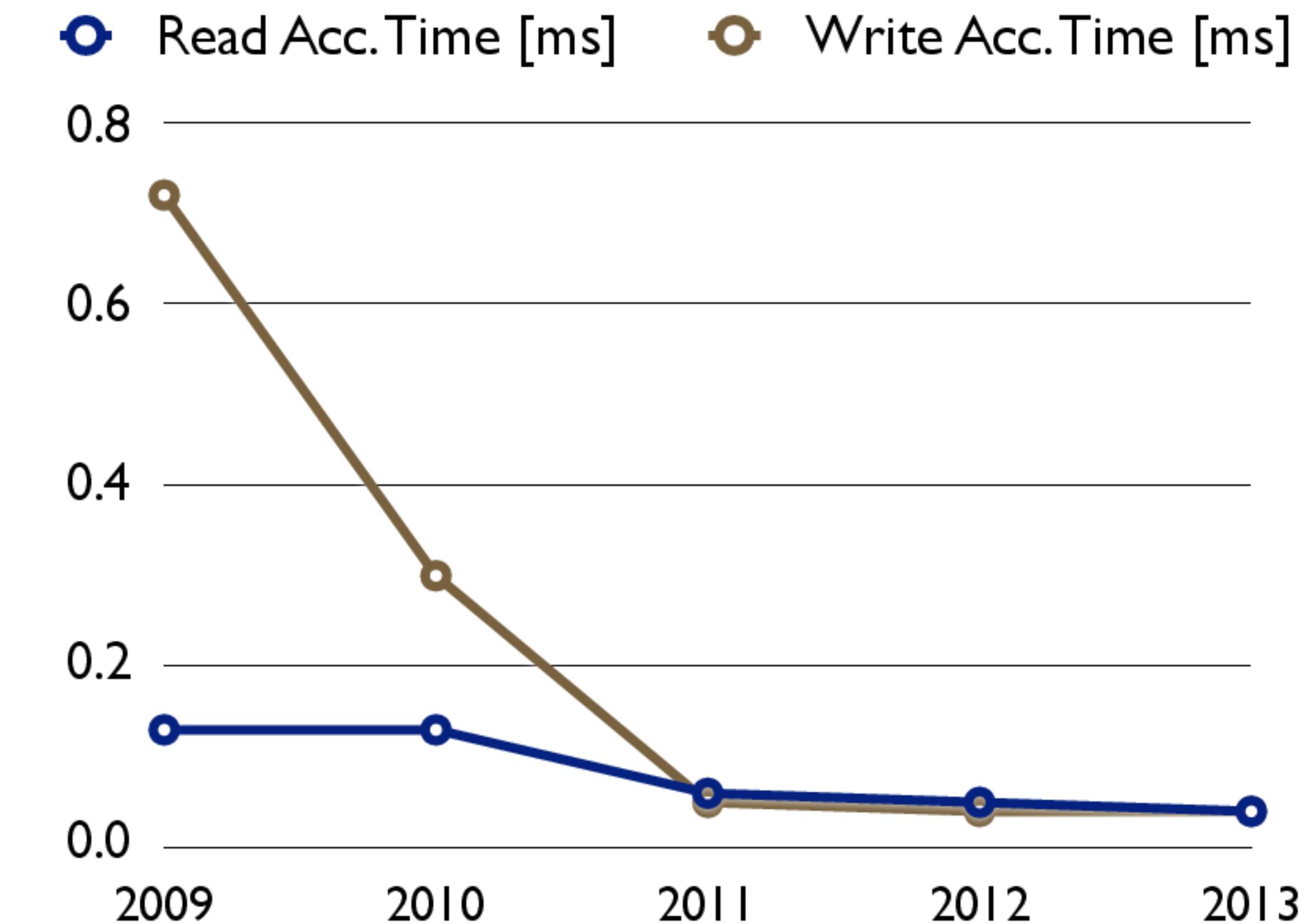
- > yet in conflict with erase-problem

- garbage collection

# Sequential and Random Speed Evolution



Keiling + wtf in



0.05 ms  
= 50  $\mu$ s

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SSD speed evolution mined from:

<http://ssd-comparison.whoratesit.com> [November 2013]