Using the Appropriate Wear Leveling to Extend Product Lifespan

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Overview

- Impact of Increasing Density on Flash Life
- Dynamic vs. Static Wear Leveling
- Other Considerations
- Conclusions

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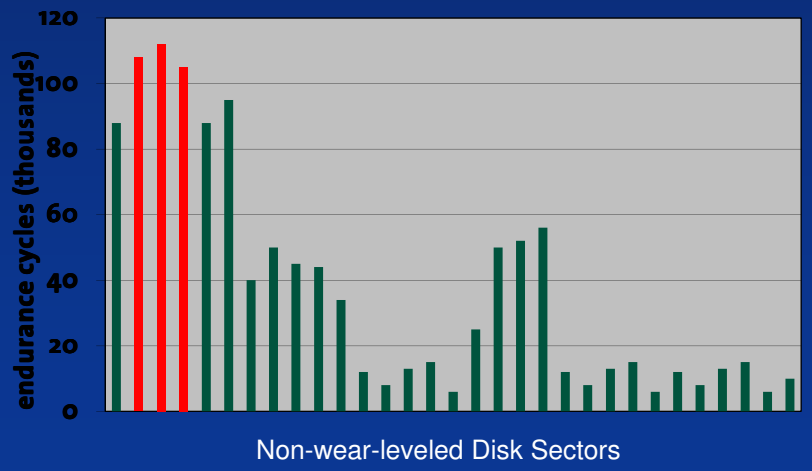
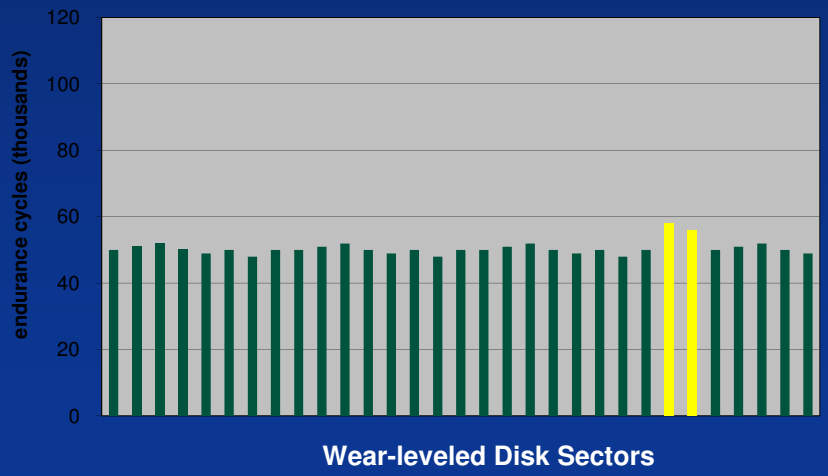
What is Wear Leveling?

Wear leveling: a set of algorithms that attempt to maximize the lifetime of flash memory by evening out the use of individual cells.

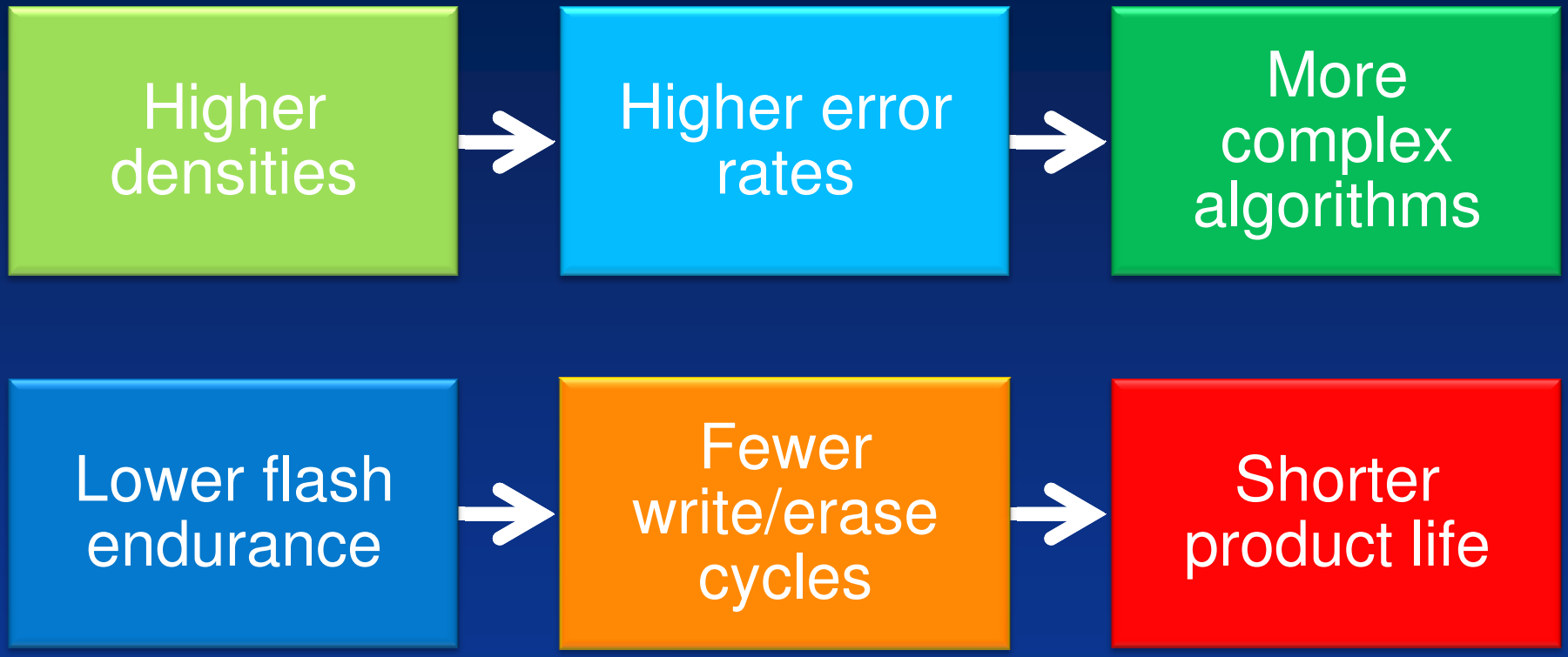


Non-wear-leveled Disk Sectors



Wear-leveled Disk Sectors

Growing Impact on Product Life



Dynamic Wear Leveling Common

- Largely inherent in any flash file system
  - Overwrites are error prone or not allowed
  - Writes to NAND must be sequential
- Effectiveness is based on application use case
  - How much data is unchanged?
  - Only works on areas of flash which are frequently updated
  - Static data therefore reduces life of the flash

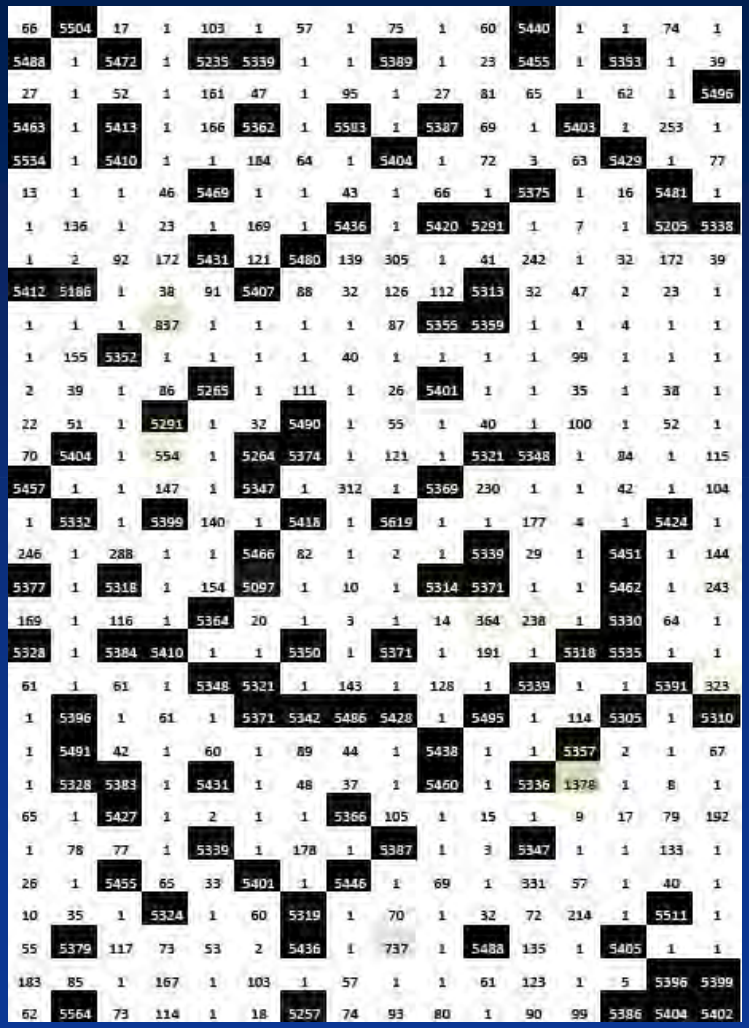
Static Wear Leveling Considers Entire Flash Media

- Does not happen automatically, software must purposely evaluate untouched areas
- Effective regardless of use case
  - Static data reduces writeable flash area
  - Overly aggressive implementation can actually reduce flash life.

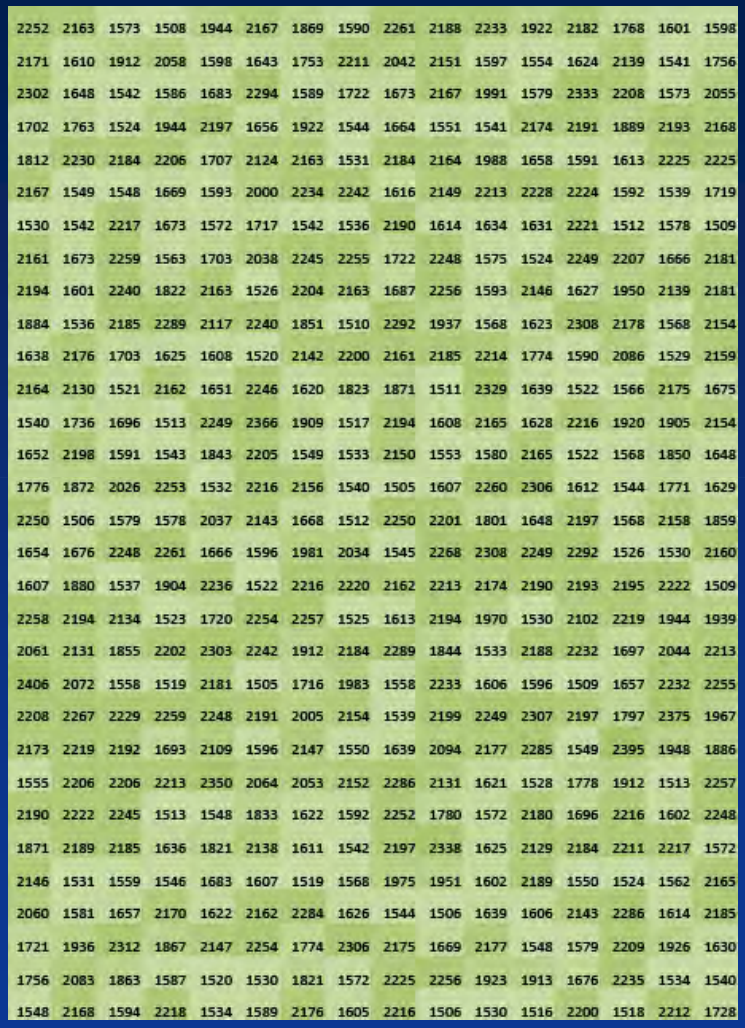
Static vs. Dynamic

- Both approaches are required for an effective wear leveling solution.
- Dynamic is low effort and reduces the complexity of static implementations
- Static ensures that media life is maximized

A Dynamic vs Both Case Study



Dynamic Only



Dynamic + Static

No Such Thing as a Free Lunch

- Static Wear Leveling
  - Distributing writes across the media reduces read and write performance
  - Does not recover writeable space
  - Statistical implementations may not handle certain use cases or break down entirely

No Free Lunch

- Excessive reads introduce errors too!
  - Bit disturb errors may go undetected
  - Aggressive algorithms may increase error rates
- Wear level operations should be bounded
  - Impacts to performance must be low.
  - Take advantage of idle time if possible.

Conclusions

- Wrong wear leveling algorithm will shorten product life
- High density SLC and MLC NAND makes it a critical component.
- Important to use both static and dynamic together
- Ensure the implementation meets application needs in performance and reliability