WARM: Improving NAND Flash Memory Lifetime with Write-hotness Aware Retention Management

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Motivation

Background: Relaxing internal retention time of flash memory improves lifetime

Problem: Refreshes typically required to guarantee data integrity, but consume additional writes → potential lifetime improvements restricted

WARM: Write-hotness Aware Retention Mgmt.

- Physically partition pages into two groups using write frequency: write-hot and write-cold
  - Virtual queues for dynamic page reclassification
  -Cooldown window to minimize ping-ponging

- Apply different policies (garbage collection, wear-leveling, refresh) to each group

WARM Results

Lifetime Improvements

Performance Overhead

Increase in Endurance Using WARM-Only

Reduction in Refresh Operations w/ WARM