Optimizing Storage Caching for Zoned Namespace Solid State Drives
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Research Challenges and Objectives

Objective: optimize ZNS caching to minimize write amplification while maintaining high HR
Challenges:
1. Which zone should be cleaned? Victim Zone Selection
2. Which blocks in the victim zone should be reclaimed? Block Reclamation

Cache Locality Aware Garbage Collection

Cache Locality Aware Victim Zone Selection (ts_score): Summation of timestamps in a zone can indicate low cache locality, i.e., old data.
Cache Locality Aware Block Selection (DynamicRWSS_t): Capturing the RWS of each window interval predicts the

Trace Profiling/ Window Size Analysis

● Rwss_t uses a set data structure to track a block’s memory access
● 23 Alibaba traces chosen for analysis on the window size to capture Rwss_t
● Average Rwss_t follows logarithmic fit as window size is increased
● Kneedle Algorithm used to programatically determine knee point

Hypothesis:
Using the knee point as the window size allows for threshold calculations that accurately portray locality of the data within the cache. Each rwss_t within this given window can be used to calculate the best threshold value to determine the eviction status of a block within a zone.

Evaluation Results

● Comparable HR and significant decrease in WAF from baseline
● Device 714: 94% drop in WAF with only 3.7% drop in HR
● Effectiveness of the Cache Locality Aware Block Selection Policy to evict valid, but less valuable data.

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References

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