A MEAN FIELD MODEL FOR A CLASS OF GARBAGE COLLECTION ALGORITHMS IN FLASH-BASED SOLID STATE DRIVES

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Garbage collection (GC) algorithms play a key role in reducing the write amplification in flash-based solid state drives, where the write amplification affects the lifespan and speed of the drive. This paper introduces a mean field model to assess the write amplification and the distribution of the number of valid pages per block for a class $\mathcal{C}$ of GC algorithms. Apart from the RANDOM GC algorithm, class $\mathcal{C}$ includes two novel GC algorithms: the d-CHOICES GC algorithm, that selects d blocks uniformly at random and erases the block containing the least number of valid pages among the d selected blocks, and the RANDOM++ GC algorithm, that repeatedly selects another block uniformly at random until it finds a block with a lower than average number of valid blocks.
We show that the d-CHOICES GC algorithm has a write amplification close to that of the GREEDY GC algorithm even for small d values, e.g., $d = 10$, and offers a more attractive trade-off between its simplicity and its performance than the WINDOWED GC algorithm introduced and analyzed in earlier studies.