

MCR: A Mirroring-Assisted Data Reconstruction Strategy For A Channel-RAID Structured SSD

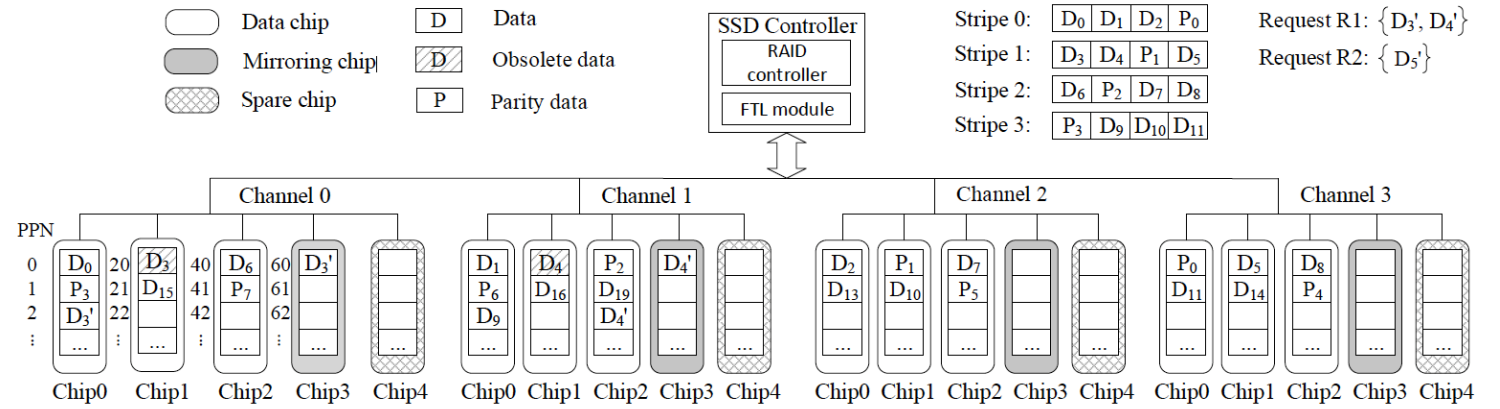


Since NAND flash memory based solid state drive (SSD) possesses some features such as high shock/temperature resistance and low energy-consumption desirable for a portable environment, it becomes an increasingly popular storage device for safety-critical mobile applications like remote robotic surgery.

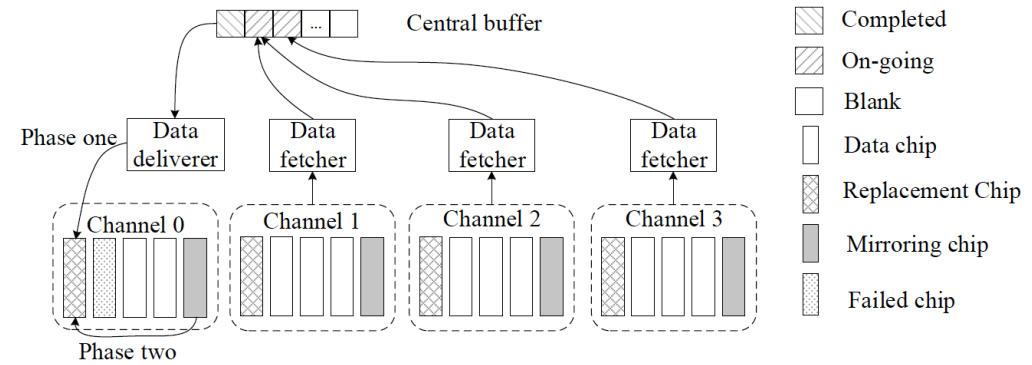
However, manufacturers are aggressively pushing flash memory into smaller geometries and each memory cell has to store more bits, which lead to a higher bit error rate that exceeds the capacity of an ECC scheme. Obviously, uncorrectable error is more detrimental to safety-critical mobile applications where data loss may cause disasters. One natural approach to enhancing data reliability is to employ a data redundancy scheme at the channel-level of an SSD. Unfortunately, simply applying an existing RAID technique to form a channel-level RAID structured SSD significantly degrades performance. In this paper, we propose a new RAID5 architecture within a single SSD to alleviate the performance degradation. More importantly, an associated data reconstruction strategy called MCR (mirroring-assisted channel-level reconstruction) is developed to shrink the length of the reconstruction time (i.e., window of vulnerability). Experimental results demonstrate that compared with the typical DOR scheme MCR on average shortens reconstruction time by 32% while delivering a similar performance during recovery.

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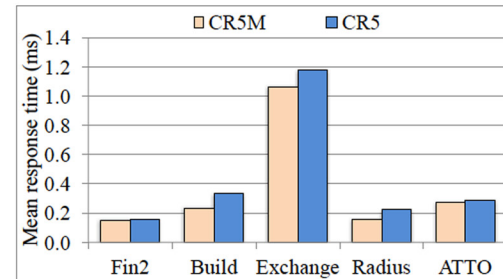
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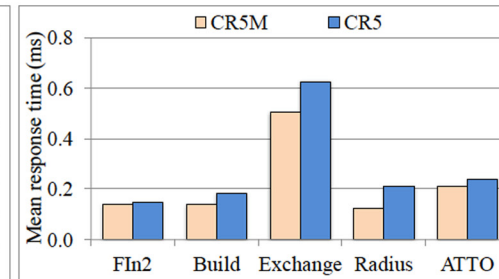
The architecture of CR5M



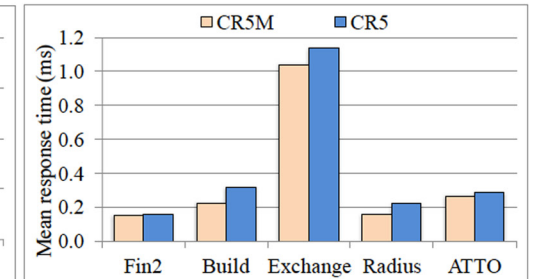
The architecture of MCR



(a) Experimental results on SSD1

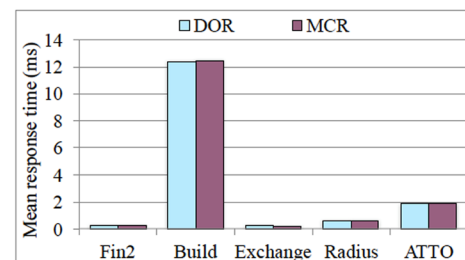


(b) Experimental results on SSD2

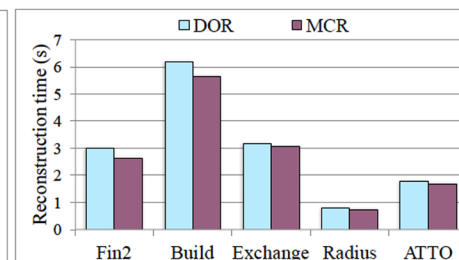


(c) Experimental results on SSD3

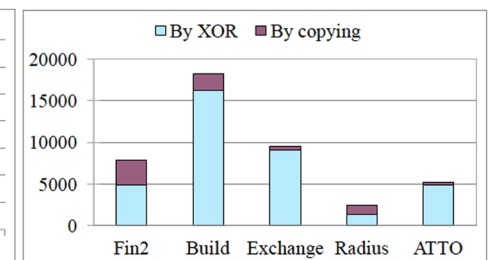
Performance evaluation of CR5M under real-world traces



(a) MRT during reconstruction



(b) Data reconstruction time



(c) Reconstructed strip count

Performance evaluation of MCR under real-world traces