

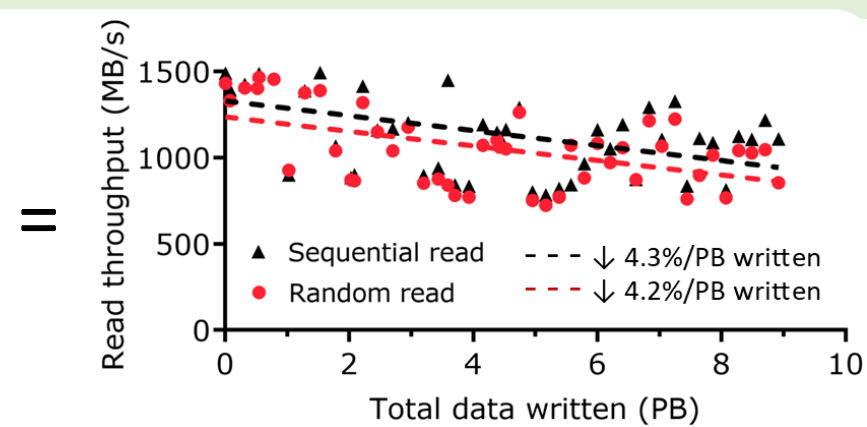


Abstract

- Modern storage systems and their ecosystem are built around hard disk drives (HDDs), which assumes that the capacity of a storage device does not change. This fundamentally negates the advantages of solid-state drives (SSDs) and causes fail-slow symptoms.
- A capacity-variant storage system maintains consistent performance by relaxing the fixed-capacity assumption.
 - CV-FS, a log-structured file system for an elastic logical partition;
 - CV-SSD, a capacity-variant SSD that gracefully reduces its exported capacity as it ages;
 - CV-manager, a capacity management interface that orchestrates system components.

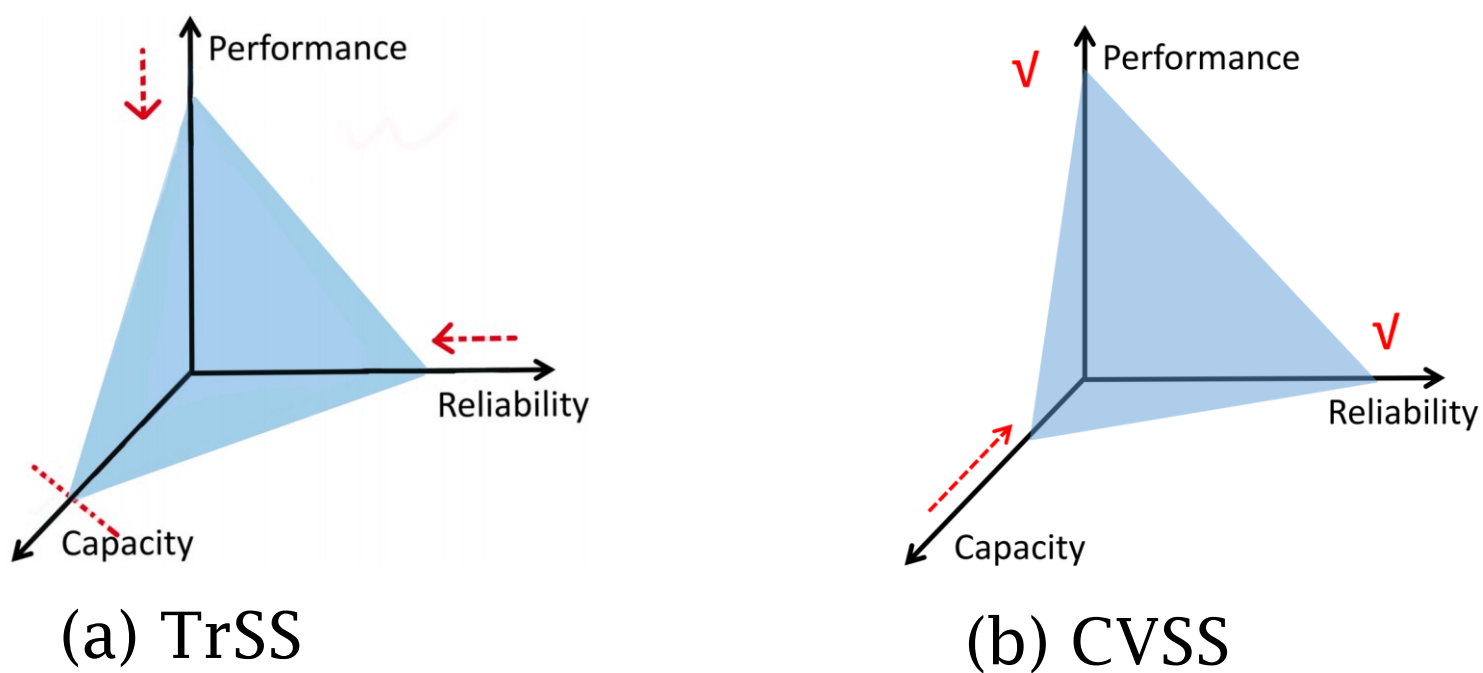
Tax from the fixed-capacity abstraction

The fixed logical capacity
+
The decreased physical capacity



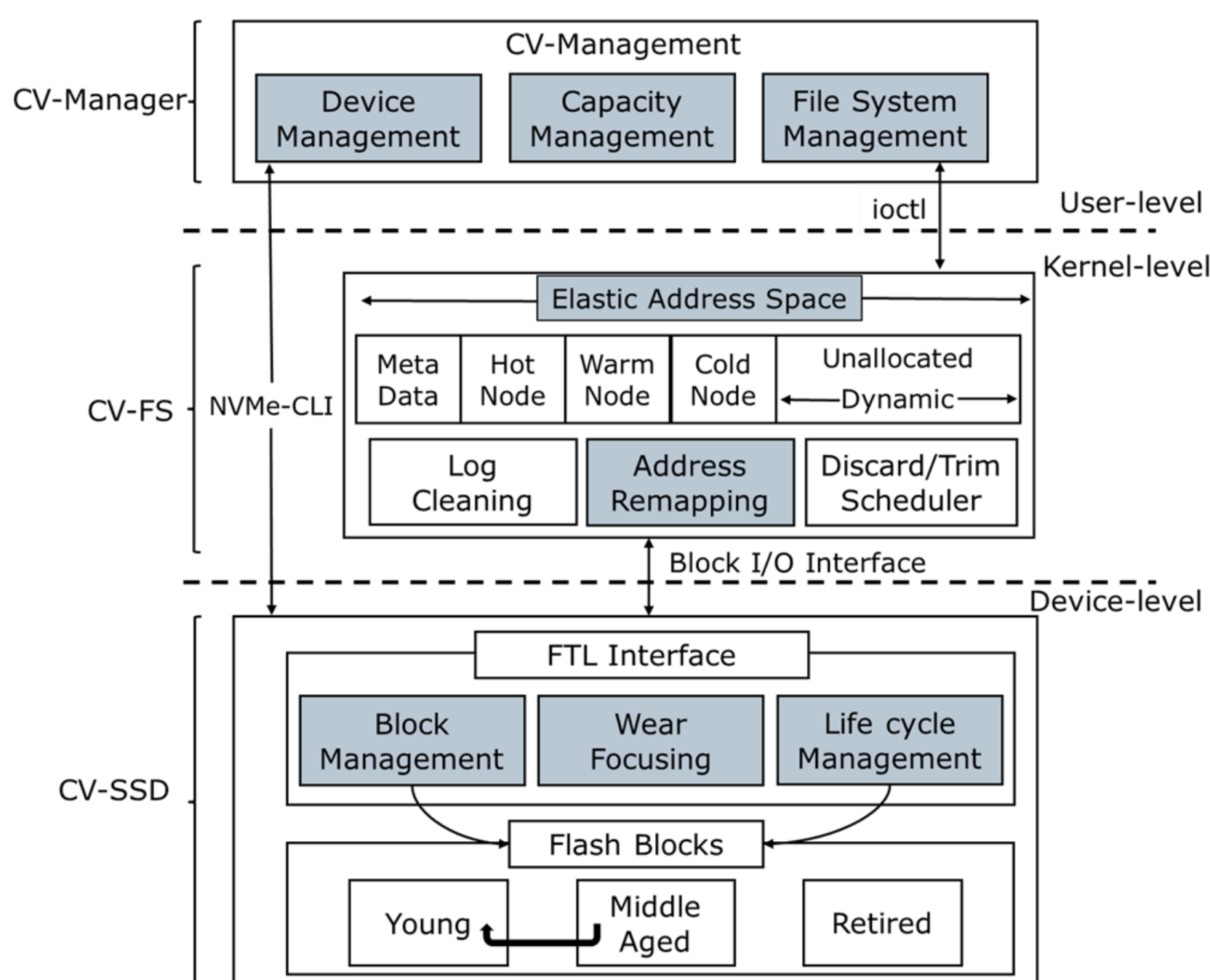
- Wear leveling & OP are required
 - Maintain an illusion of a fixed-capacity device
- Complicated error-handling (ECC, data re-read, redundancy...)
 - Manifest the fail-slow symptom
- Lifetime ends early
 - When exported capacity can't be maintained

Design principles

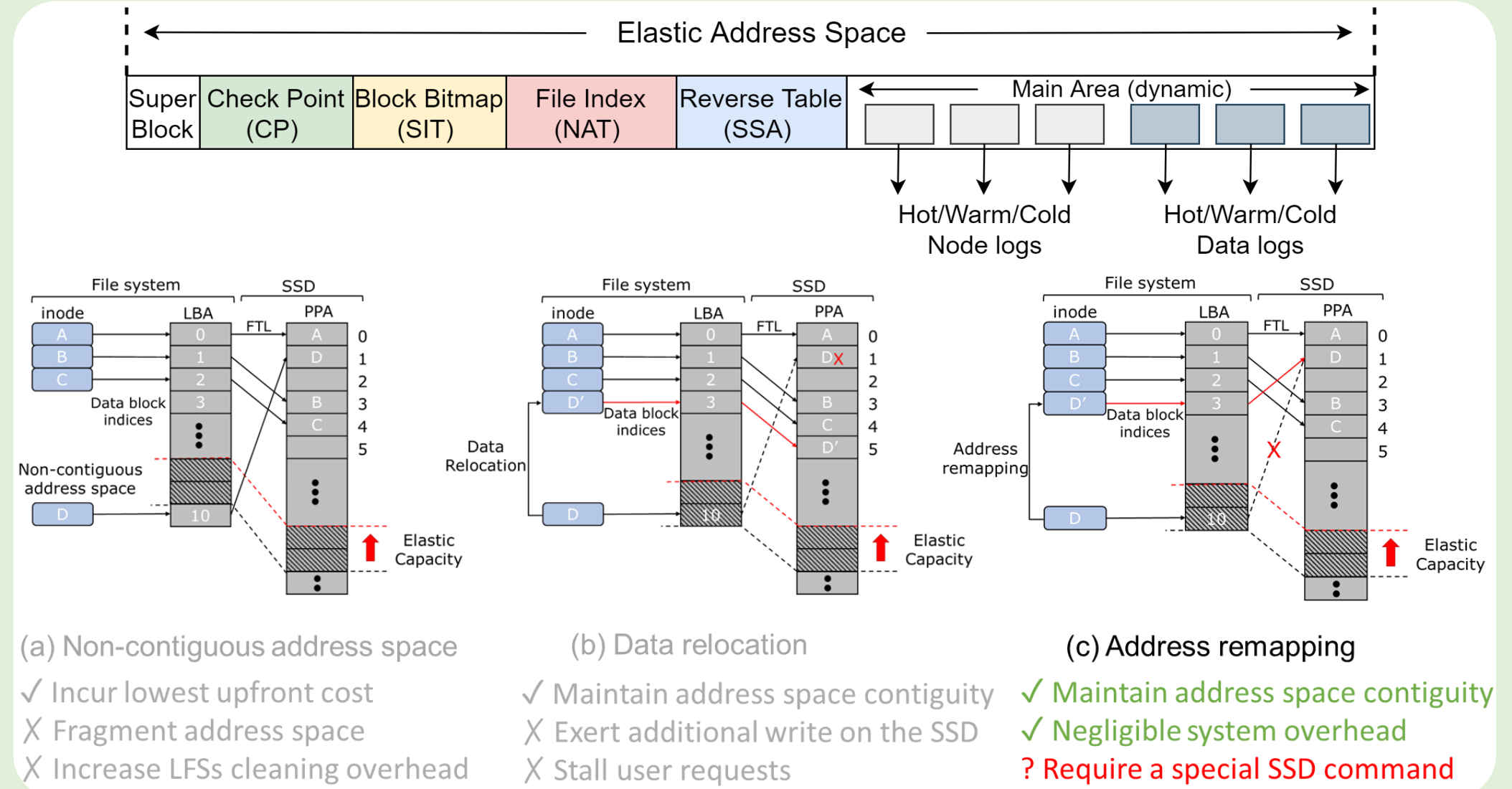


- Performant SSD even when aged
- Extended lifetime for SSD-based storage
- Streamlined SSD design.

CVSS overview

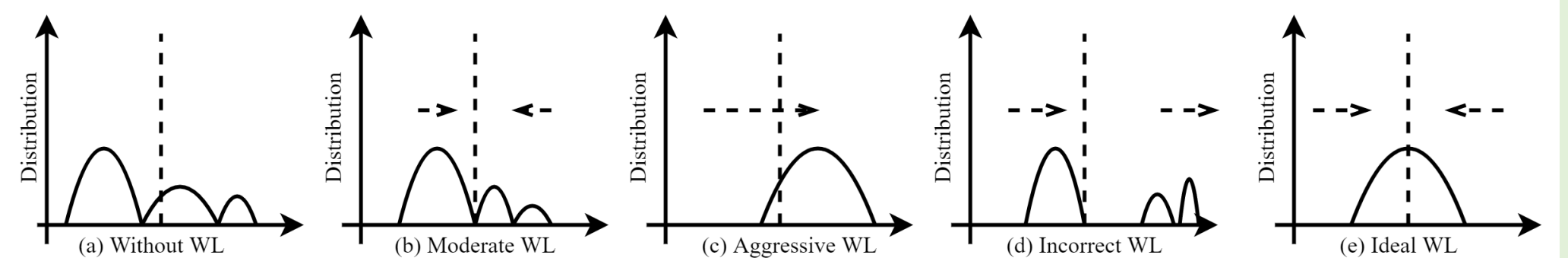


CV-FS

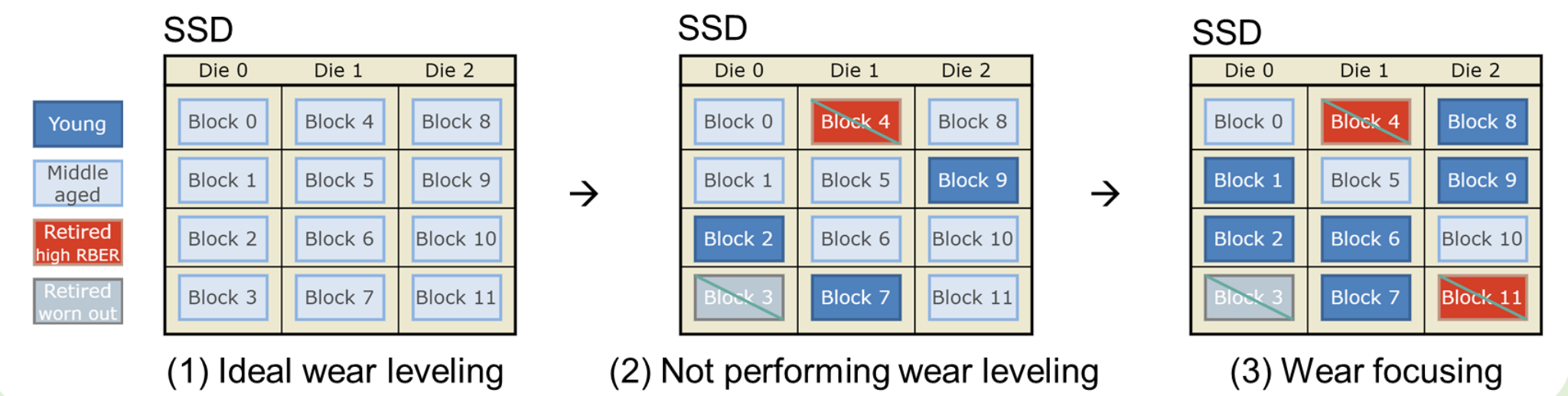


CV-SSD

- WL presents unstable behavior in conventional SSDs

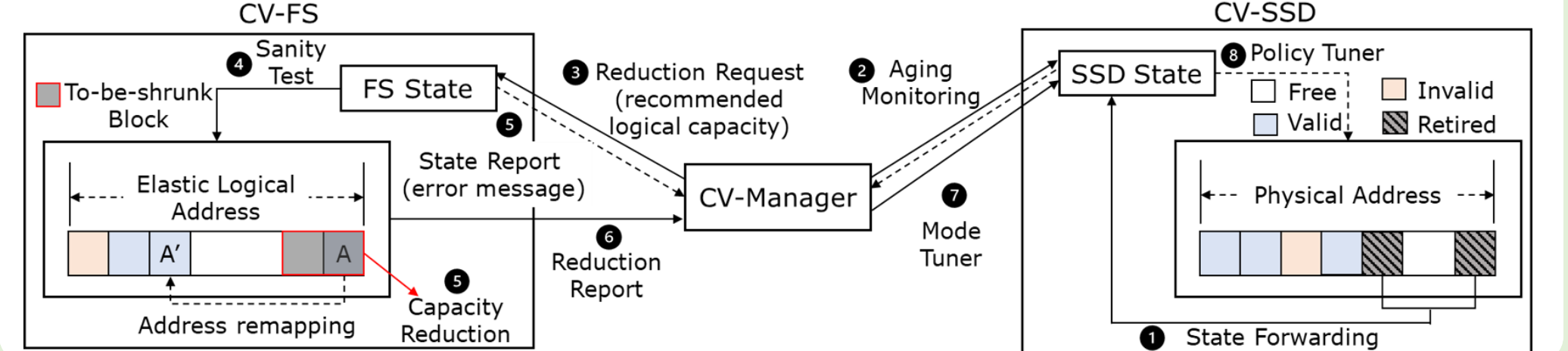


- Forgo WL and adopt wear focusing to keep most in-used blocks at peak performance and exclude underperforming and aged blocks.



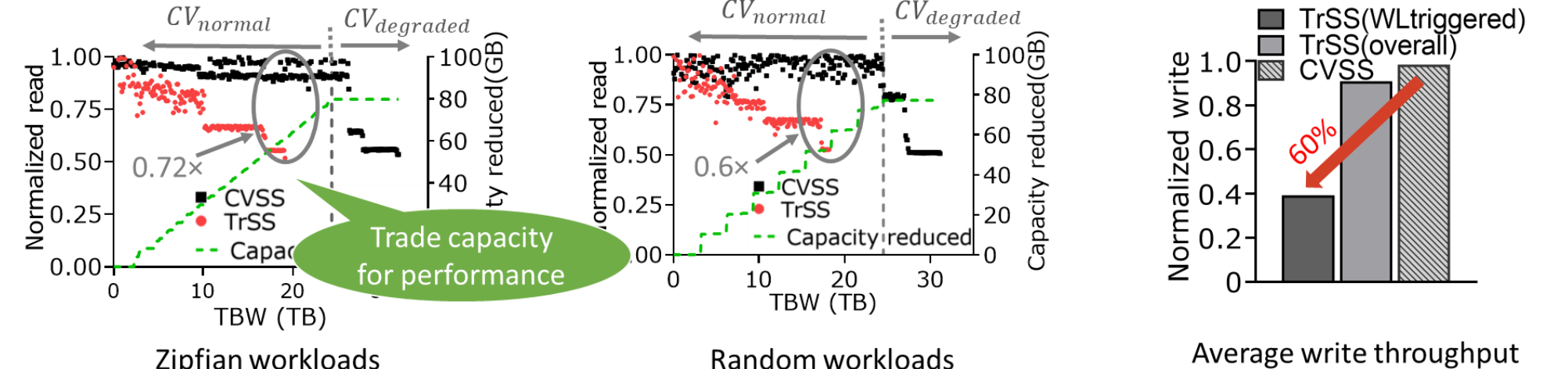
CV-manager

- Automate capacity reduction and orchestrate CV-FS and CV-SSD.

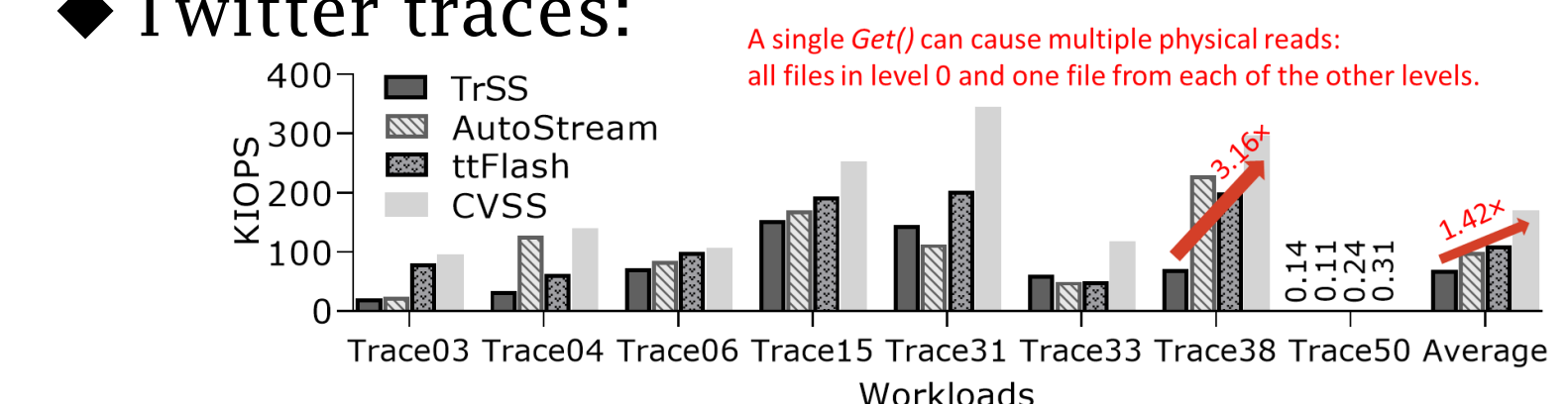


Evaluation

- Synthetic workloads:



- Twitter traces:



- Lifetime extension:

