

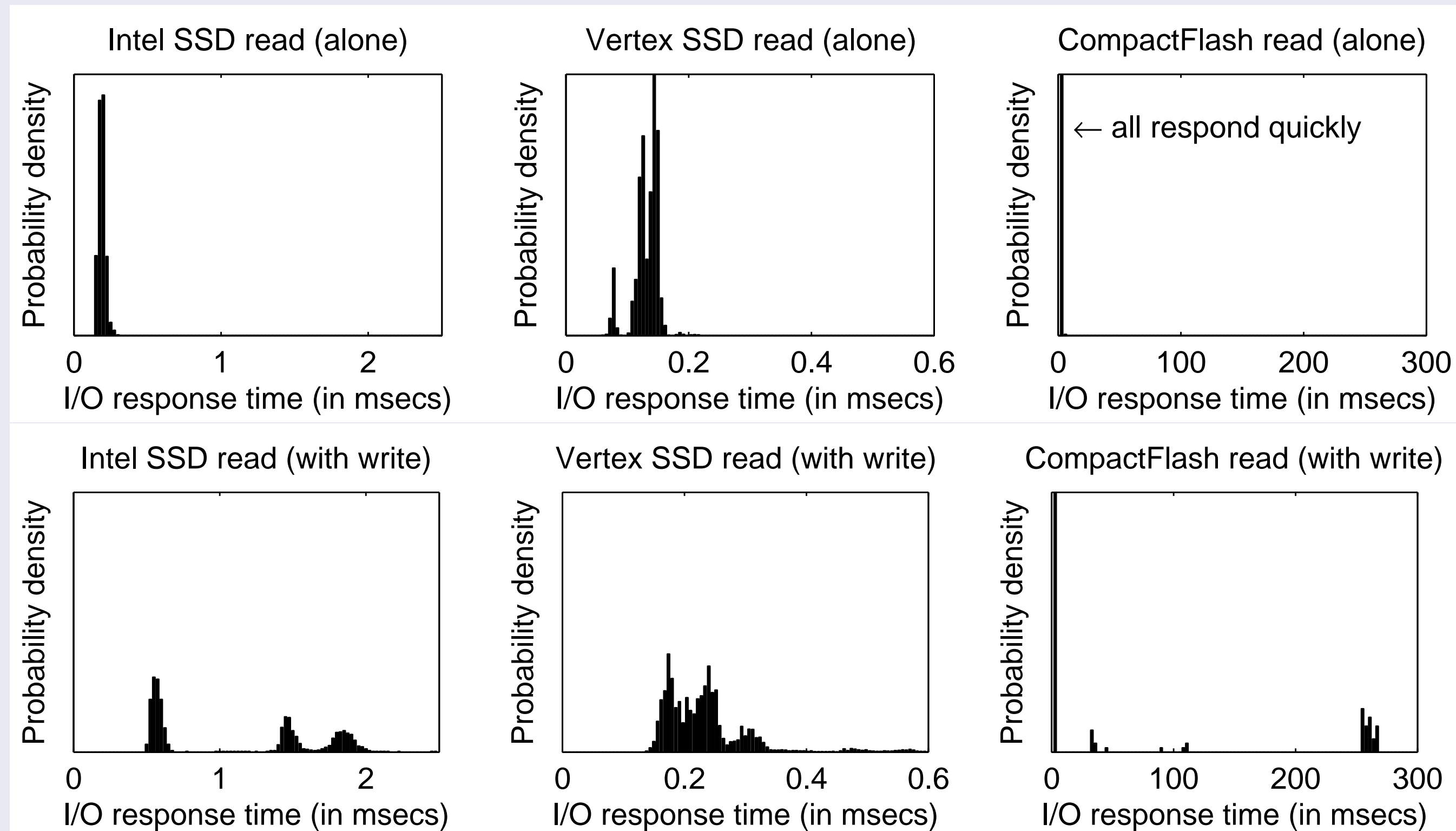
FIOS: A Fair, Efficient Flash I/O Scheduler

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Motivation

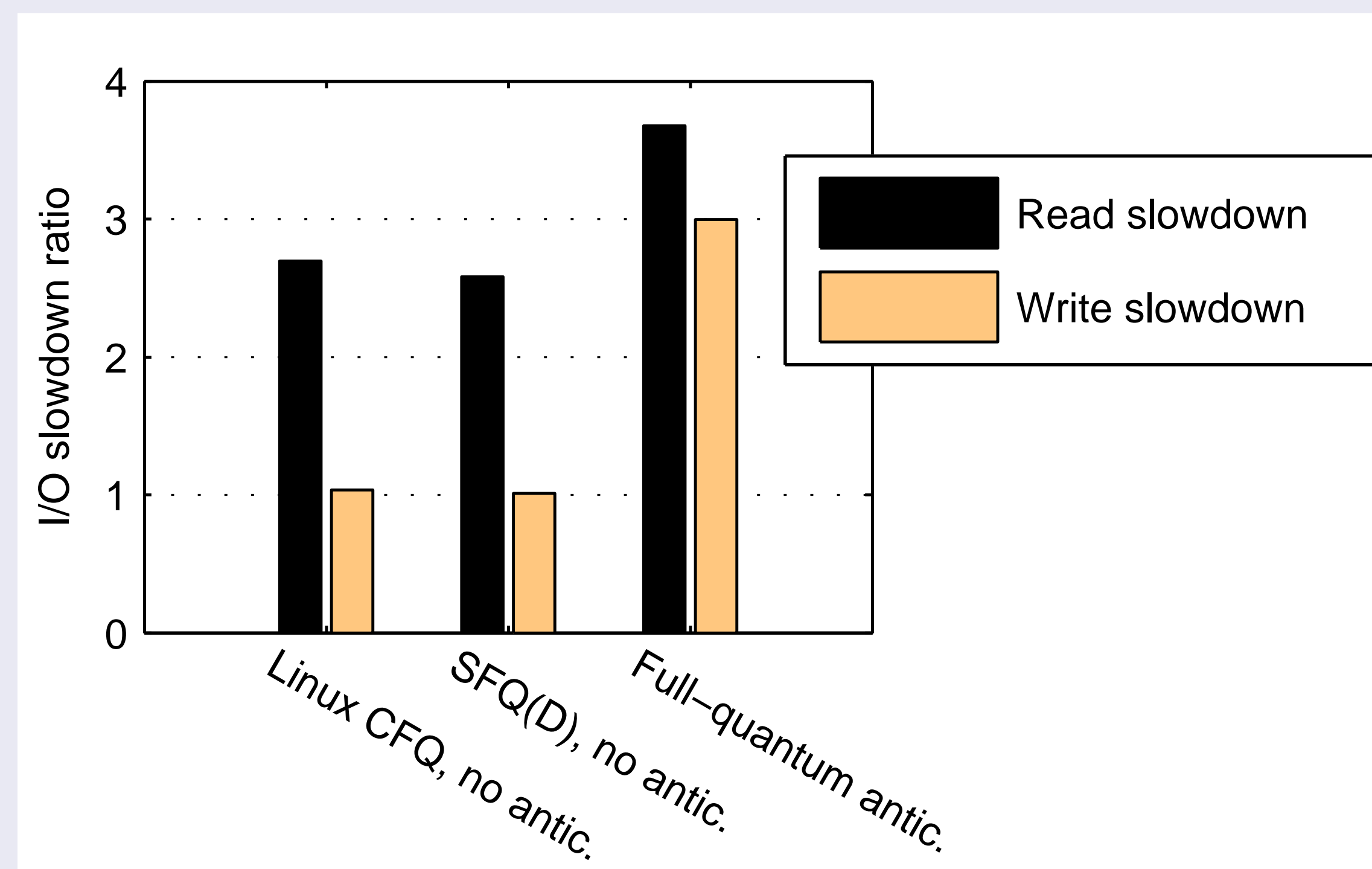
- Disk-based schedulers + Flash-based storage = poor fairness and sub-par performance
- Recognize performance pitfalls due to Flash characteristics: I/O asymmetry, read-write interference
- Exploit Flash parallelism
- Proper I/O anticipation: Deceptive idleness can hurt fairness of Flash I/O

Motivation: Read-Write Interference



Motivation: I/O Anticipation Support

- Reduces potential seek cost for mechanical disks
- ...but largely negative performance effect on Flash
- Flash has no seek latency: no need for anticipation?
- No anticipation can result in unfairness: short service, I/O interference



Lack of anticipation can lead to unfairness; aggressive anticipation makes fairness costly.

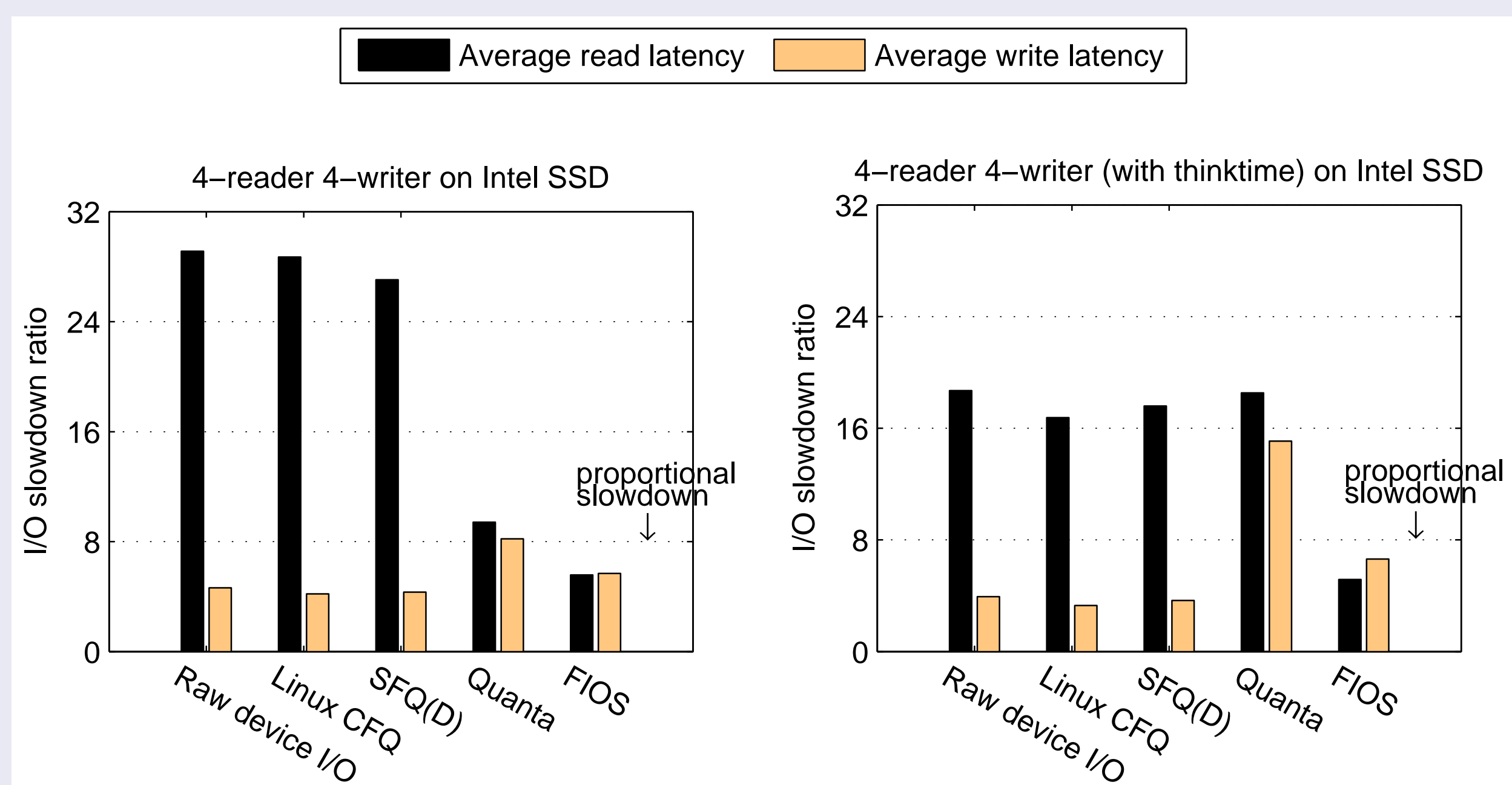
FIOS Design

- Fair timeslice management: Basis of fairness
- Read-write interference management: Account for Flash I/O asymmetry and minimize harmful interference
- I/O parallelism: Recognize and exploit SSD internal parallelism while fairly accounting for I/O cost
- I/O anticipation for fairness: Still necessary on Flash; When and how long to anticipate?

Experimental Setup

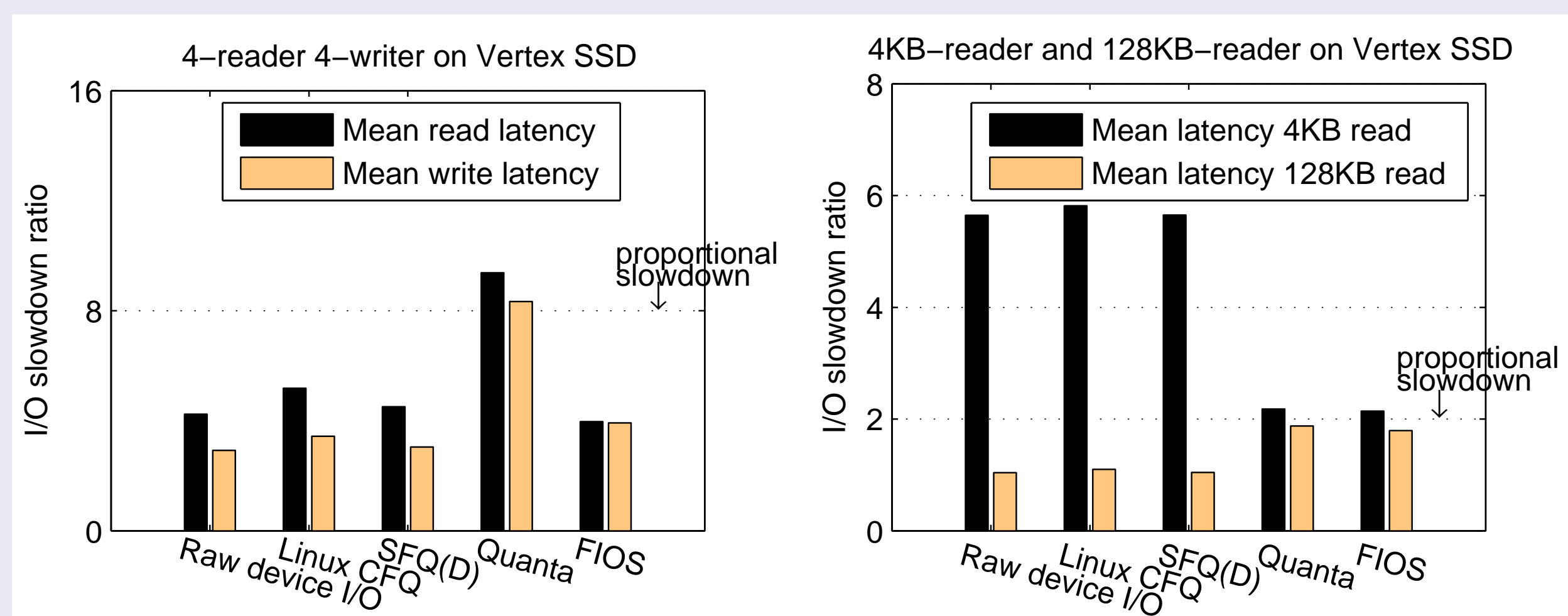
- SSDs installed in workstation; CompactFlash in low-power node
- Random I/O microbenchmarks, SPECweb+TPC-C, FAWNDS
- Fairness measured by proportional slowdown: A task running concurrently with n tasks should experience a factor of n slowdown compared to running alone.

Results: Fairness for Reads and Writes



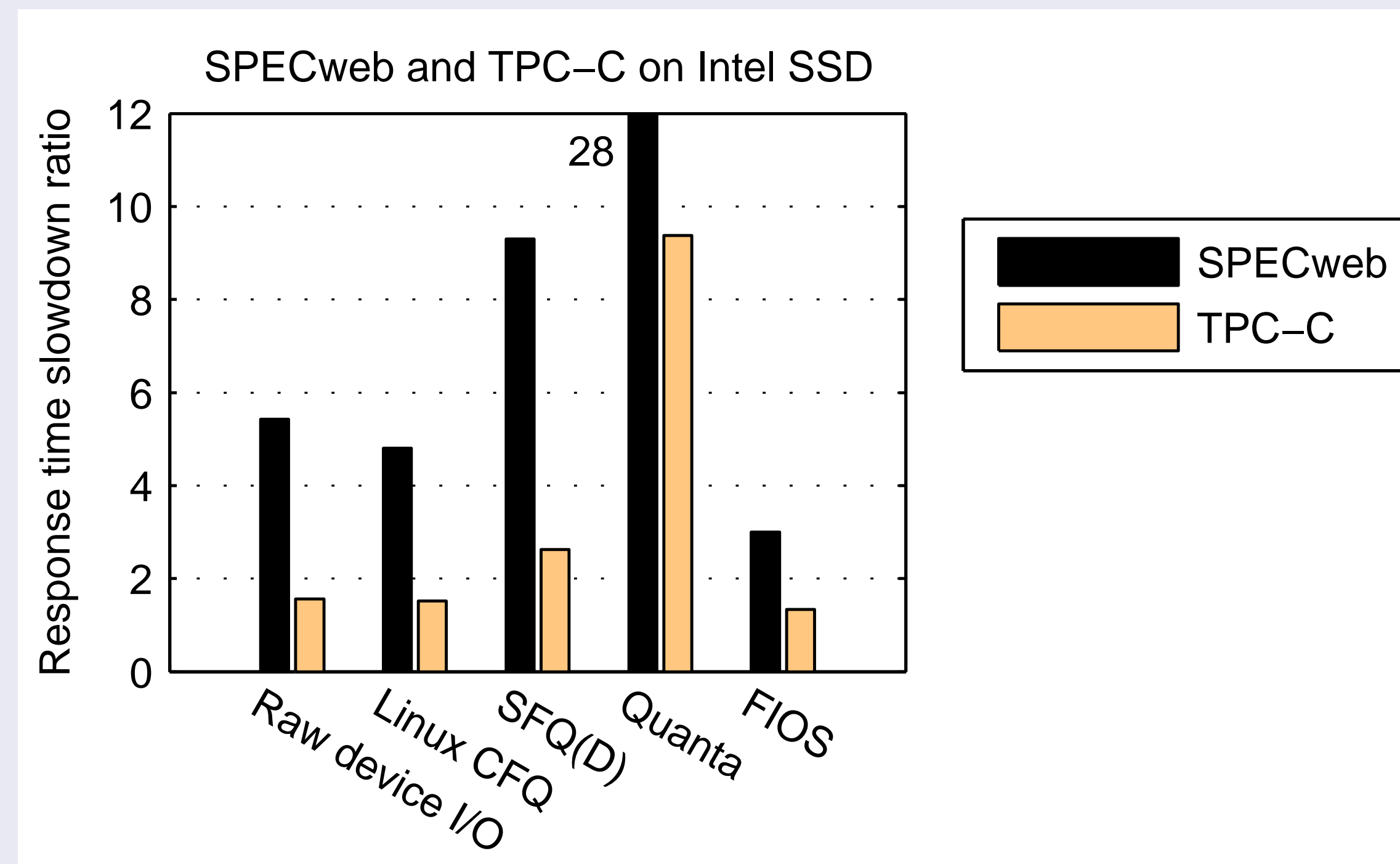
FIOS provides fairness with good efficiency under differing I/O loads.

Results: Fairness for Requests of Varying Cost



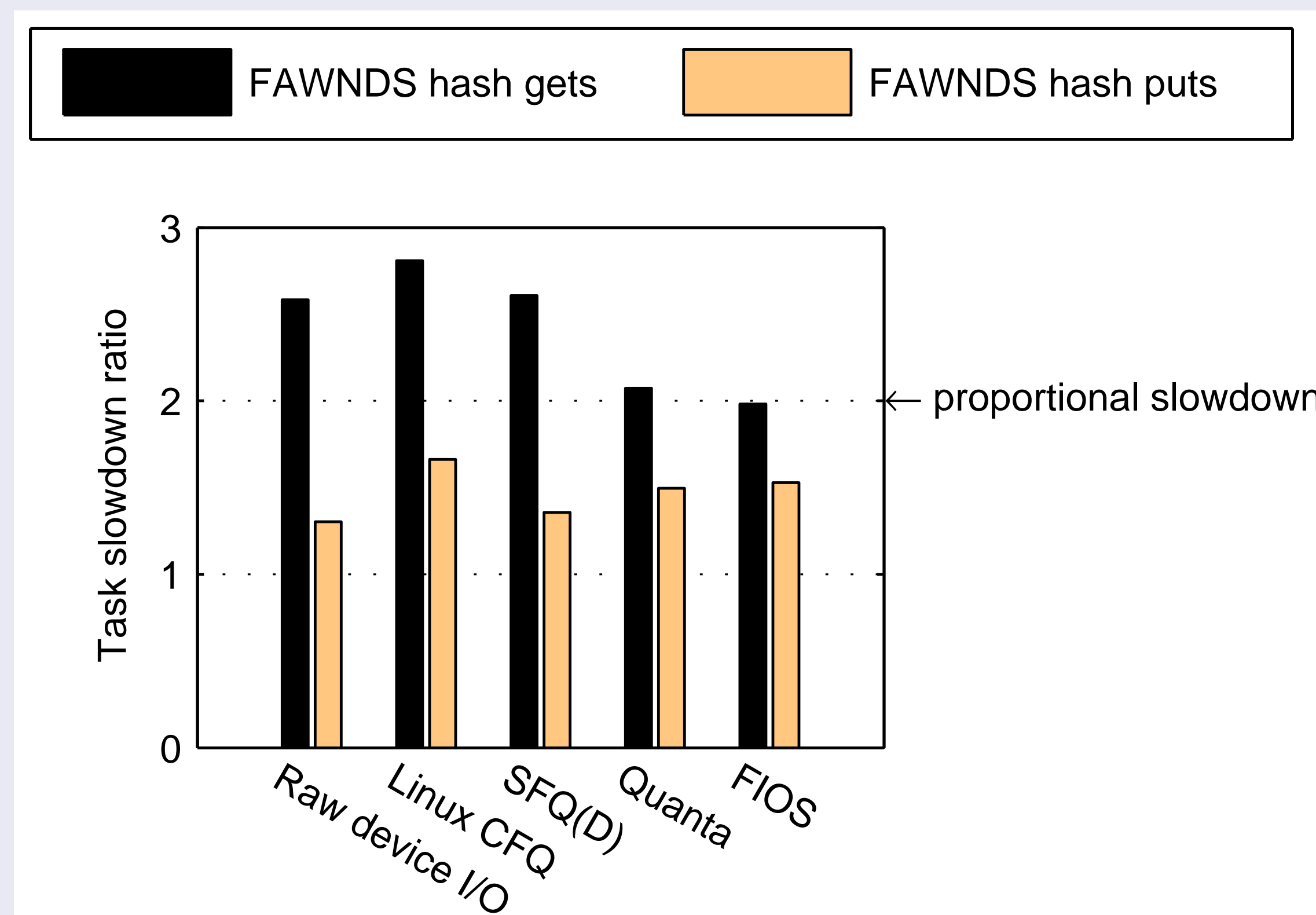
FIOS achieves fairness not only with read-write asymmetry but also requests of varying cost.

Results: SPECweb co-run TPC-C



FIOS exhibits the best fairness compared to the alternatives.

Results: FAWNDS (CMU, SOSP'09) on CompactFlash



FIOS also applies to low-power Flash and provides efficient fairness.