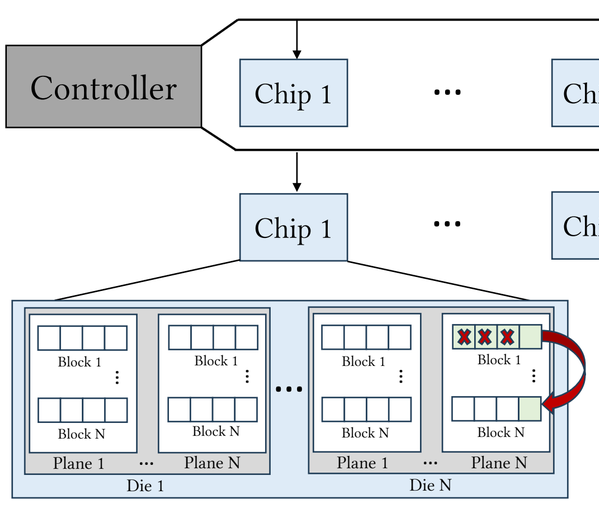
Eliminating the Hidden Cost of Zone Management in ZNS SSDs

Teona Bagashvili Tarikul Islam Papon Subhadeep Sarkar Manos Athanassoulis

SSD Background



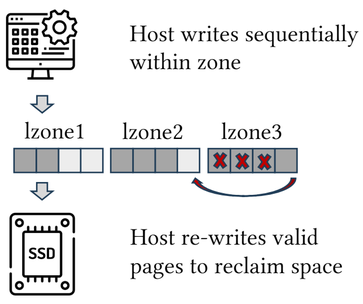
Out-of-place updates

Device re-writes valid pages to reclaim space

Interference with host I/O

Over-provisioning

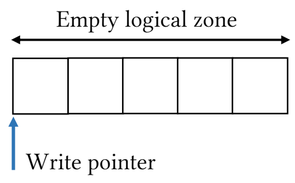
Zoned Block Interface



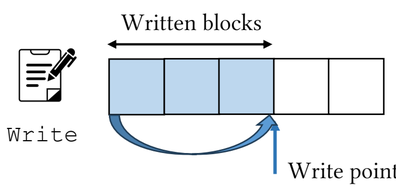
Host manages data placement

Predictable host-side garbage collection

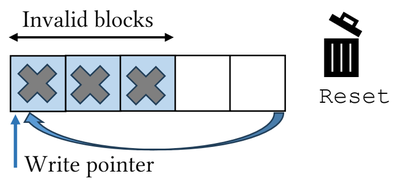
Minimal over-provisioning



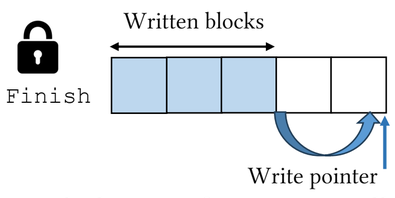
Write pointer is at the beginning of the zone



Device limits the number of partially written zones



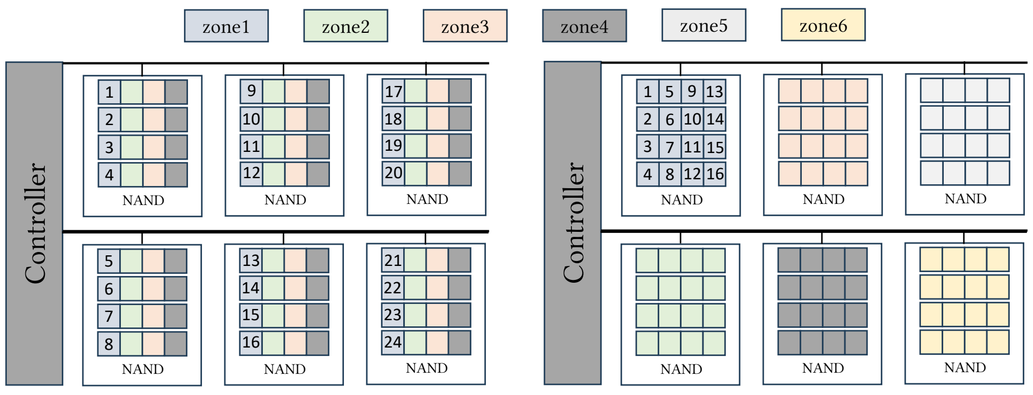
Reset the zone once all the data becomes invalid



Lock the zone for writes to allow opening a new zone

Hidden Write Amplification

Physical Zone Geometry



Larger zones

High intra-zone parallelism

Smaller zones

High inter-zone parallelism

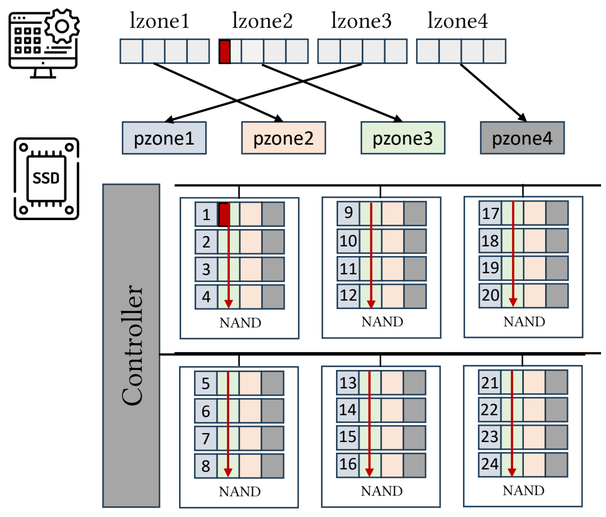
Hardware Properties

Partially written erase blocks are prone to read disturbs

Cannot assign partially written erase block to another zone

Padding partially written blocks after `finish` locks a zone

Device-side Zone Management



Logical zones are mapped to physical zones

Physical zones are fixed

`Finish` and `reset` applies to the full zone

Interference with host I/O

Device-side write amplification (DLWA)

Fast physical zone allocation

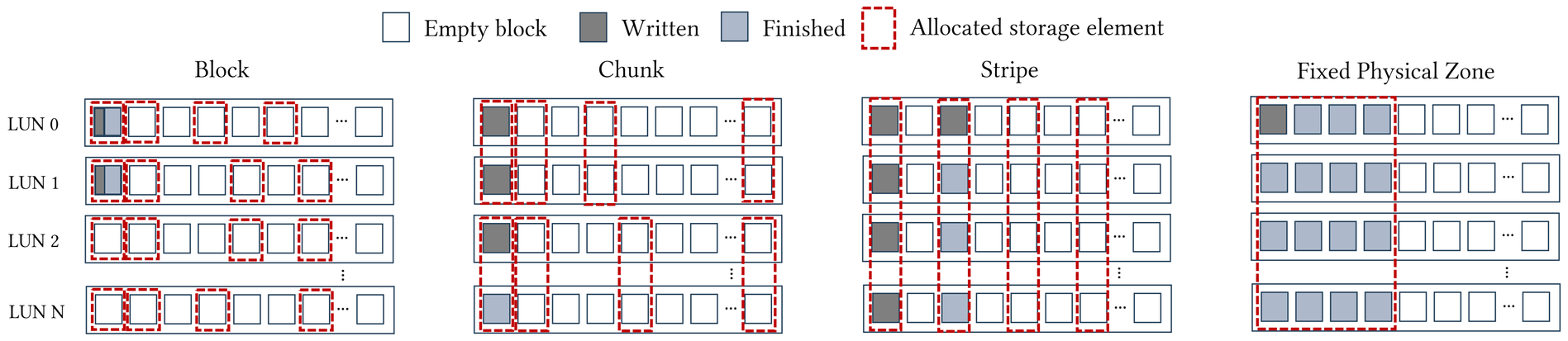
Low memory overhead

SilentZNS: Augmented ZNS Design Space

Represent hardware as a collection of **storage elements**

Partial `finish` and `reset` to **minimize device-side write amplification**

Zone geometry to balance throughout and DLWA



Highest metadata and zone allocation time overhead

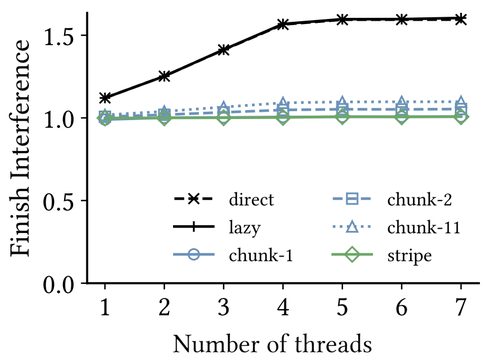
Least DLWA

Balance DLWA, throughput, metadata and allocation time

Lowest metadata and zone allocation time overhead

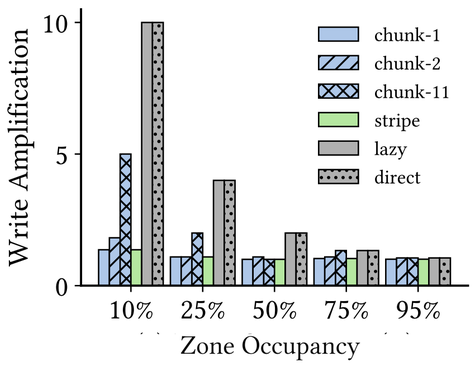
Most DLWA

SilentZNS Performance Evaluation



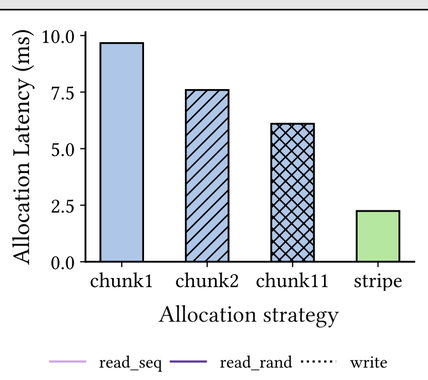
SilentZNS **reduces the interference** with host I/O

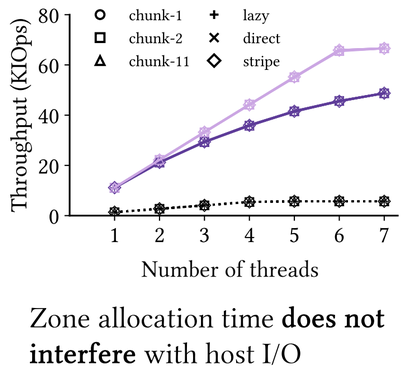
Chunk-1 and stripe configurations have **lowest interference** with host I/O



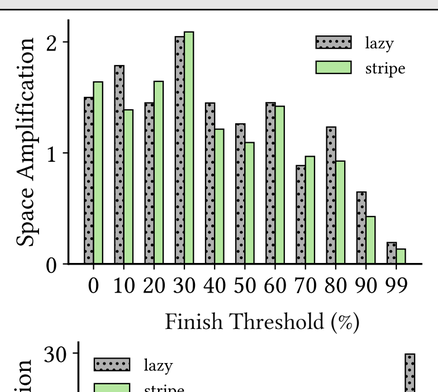
SilentZNS **reduces the DLWA** by up to 86.36%

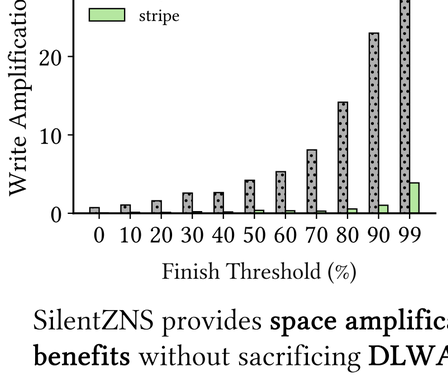
Chunk-1 configuration provides the lowest DLWA





Zone allocation time **does not interfere** with host I/O





SilentZNS provides **space amplification benefits** without sacrificing **DLWA**

BOSTON UNIVERSITY
College of Arts & Sciences
Department of Computer Science

disc.bu.edu