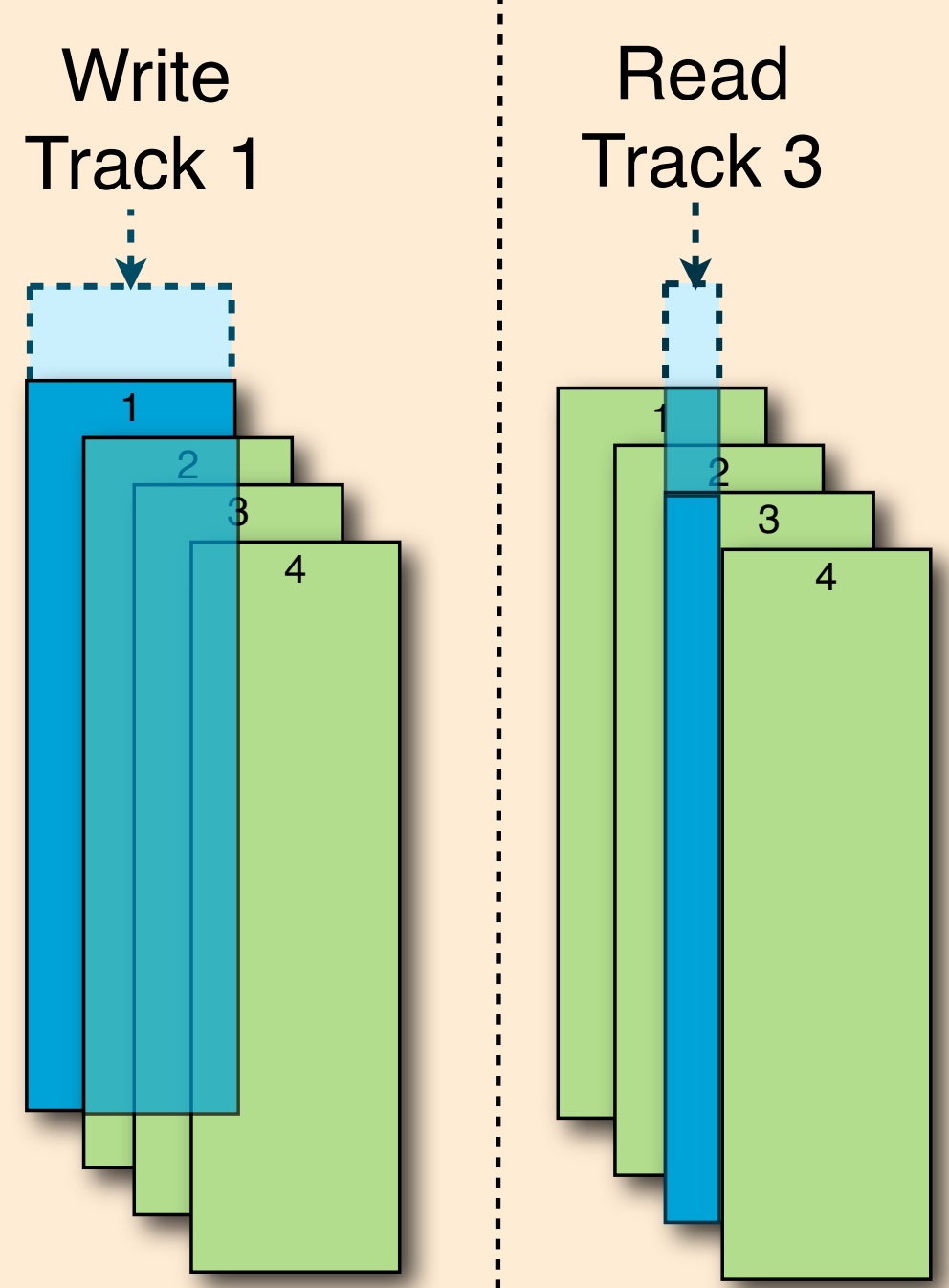


## Motivation

- Shingled writing promises ~2.3x areal density increase
  - But different write characteristics than hard disks
- Further research hindered by the unavailability of a Shingled Write Disk(SWD)
  - Emulate one on a hard disk drive

## Shingled Write Disk

- Hard disk with Shingled tracks
- Wider write head; narrow read head
- Write overwrites next k tracks
- Random writes may destroy data
- Unrestricted reads



## Emulation

### Goals:

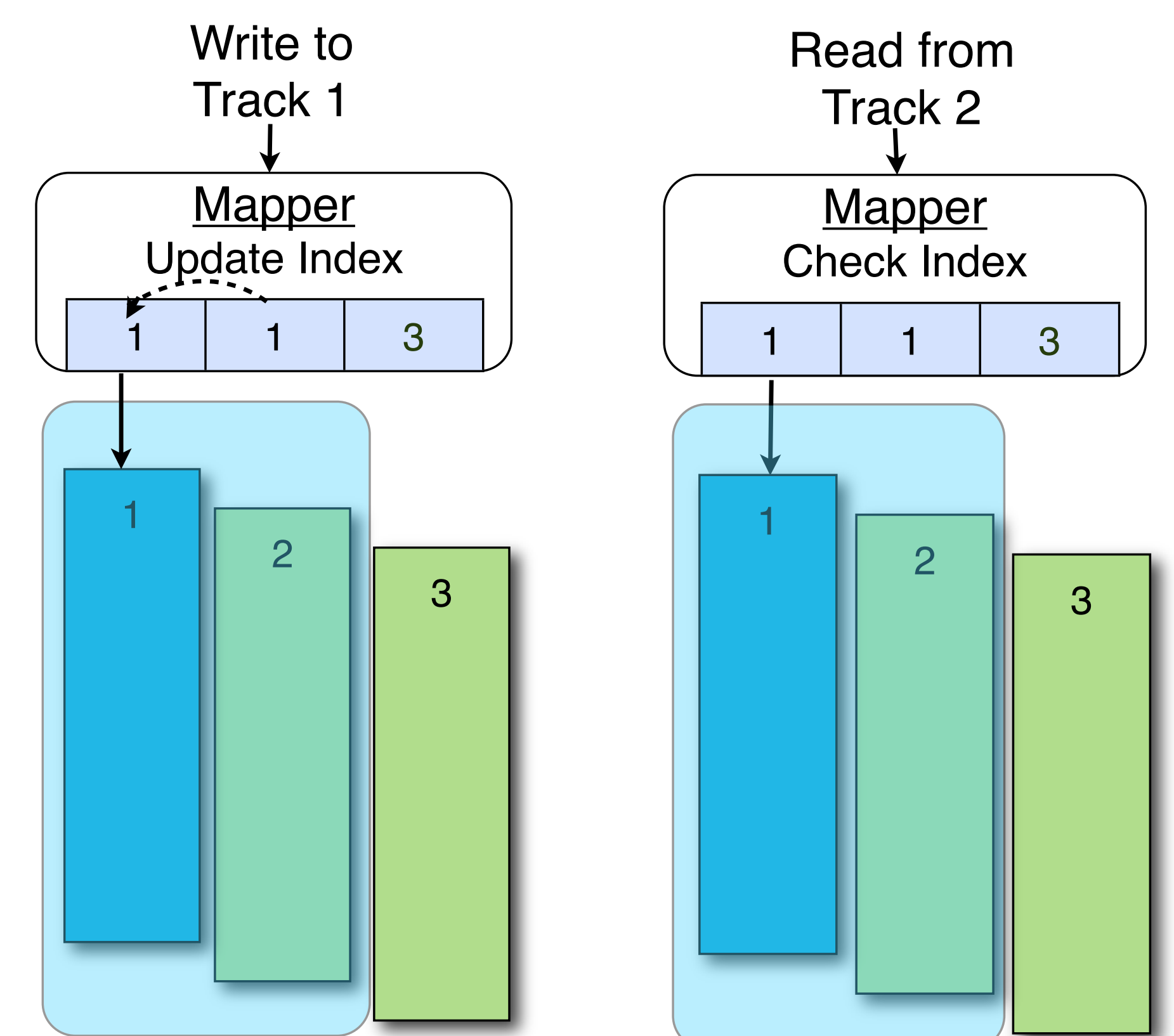
- Mimic the Shingled Write behavior
- Usable to verify and validate SWD layout management solutions
  - Work with a real hard disk of desired model
  - Store and retrieve data
  - Measure near to accurate performance values
- Ability to add new functionalities
- Like report physical geometry values

### Why not extend DiskSim?

- Models only the performance-related aspects of the storage subsystem
- Does not actually save or restore data for each request
- Older disk models

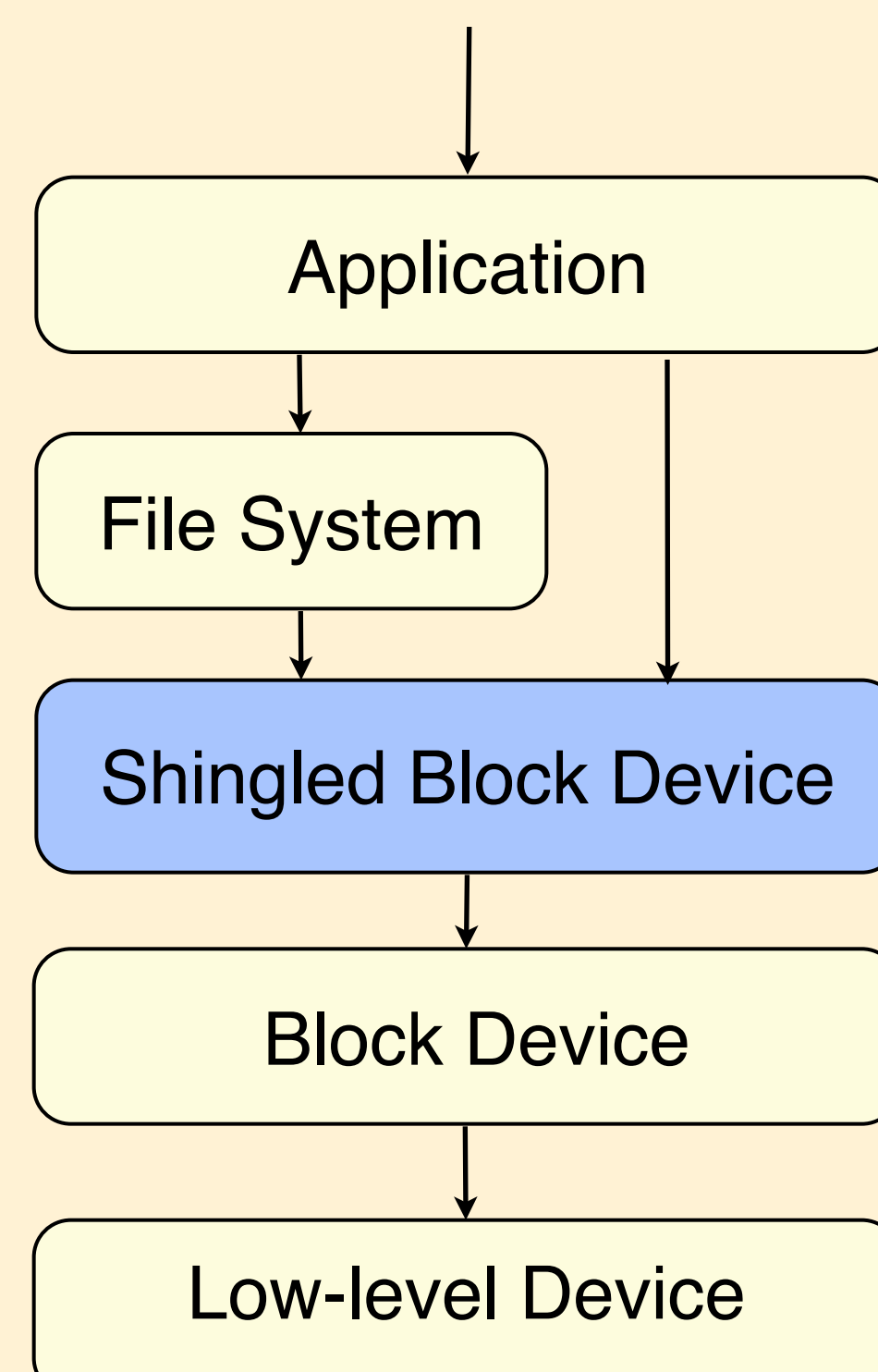
**Approach:** Track overwrite by 'shingled' writes using a map table

- Write - point next K tracks to the current track
- Read - check table and read from track pointed to



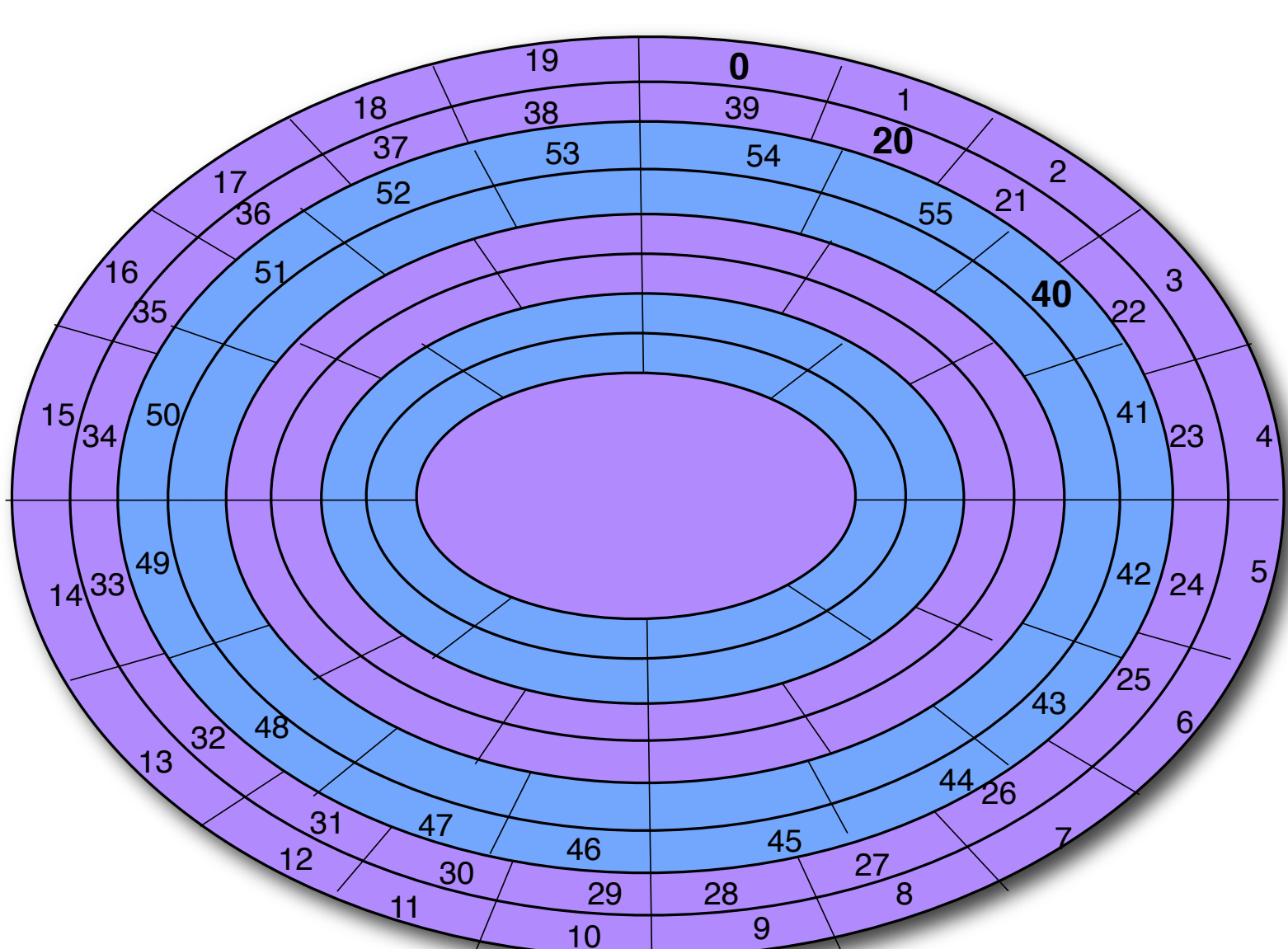
## Implementation

- Implemented a block device driver in Linux 2.6 kernel
- Closely mimics device by taking the underlying disk's physical geometry into account
- Create a Shingled block device; mapping at block level
- Tested with geometry values of a single platter 160GB Seagate SATA drive
- Can report geometry values on request



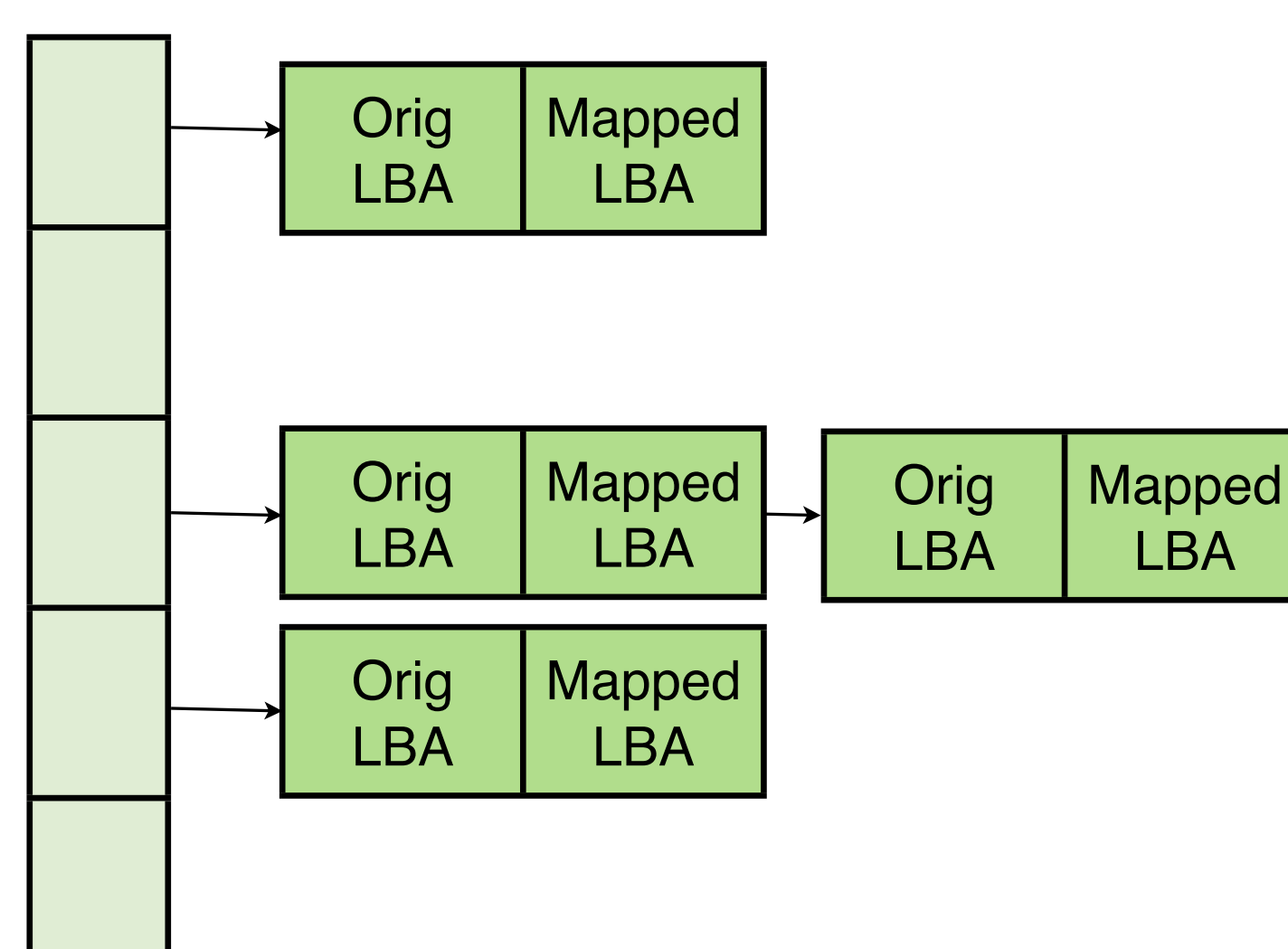
### Hard Disk Geometry

- Required to determine LBA of overwritten sectors
- E.g., to determine that 39 and 54 is overwritten by a write to 0, when k=2:
  - Num of Zones, Num of Tracks per Zone, Num of Sectors per Track per Zone, and Track Skew



### Hash Table

- Contains mapping information; Entries only for sectors that were overwritten
- Add entries for affected sectors on Writes (e.g., entries for 39 and 54)
- Delete entry for sector being written if it exists (e.g., entry for 0)
- Entry lookup on Reads



## Conclusion

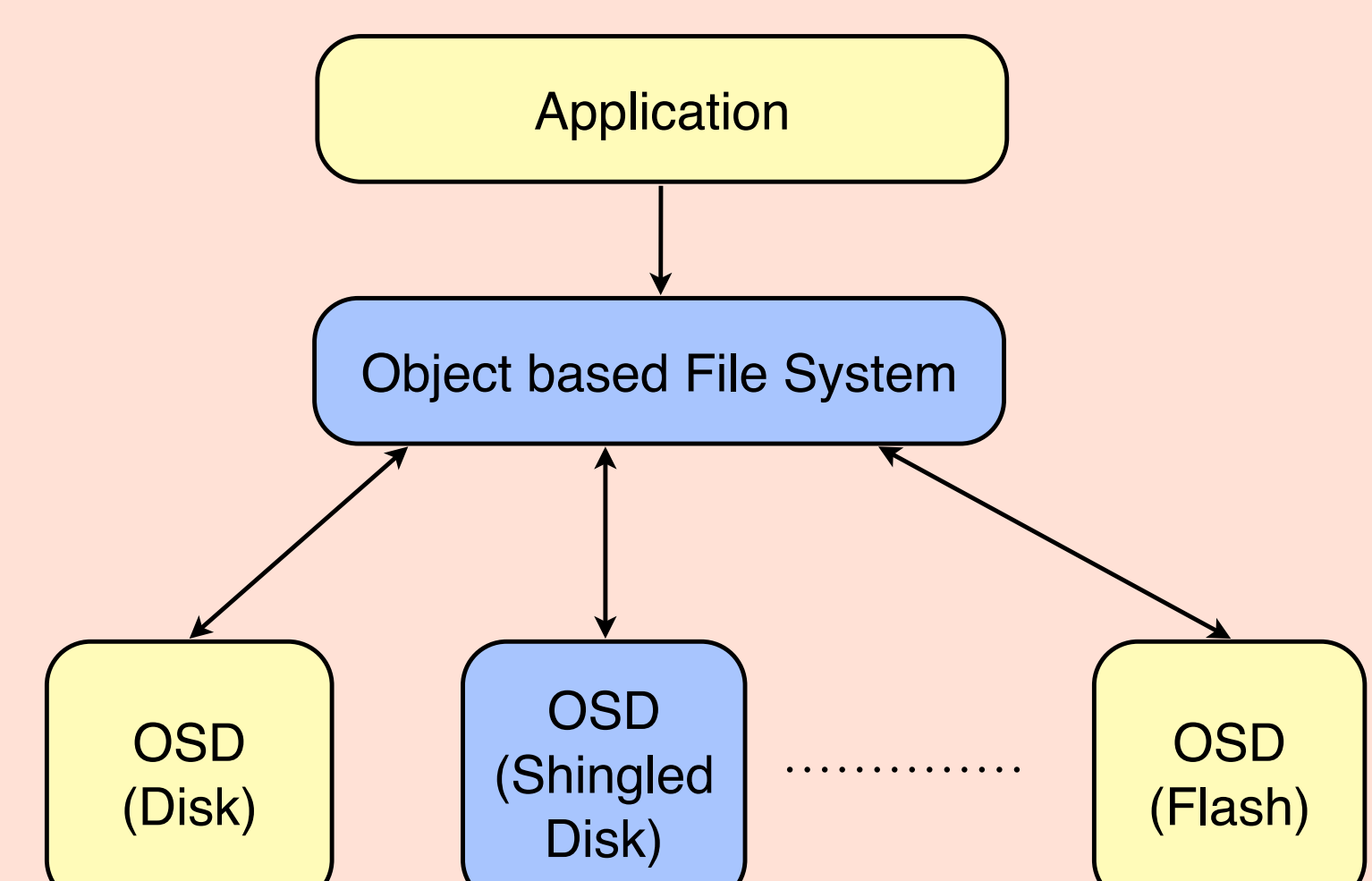
- SWD Emulator fills gap till SWD is available
- Unique features makes it useful even after
  - Device can report physical geometry values
  - Most SWD layout management solutions, need to be aware of the underlying disk's geometry
  - Can be modified to add new device functionalities
  - New 'ioctl' commands, banded device, etc.,

### Current Status:

- Evaluating our driver to verify and validate the shingled disk operations
- Plan to make it available online to facilitate other research as well

### Future Work:

- Host level management gets harder as geometry is tailored to individual drives
- We believe in hiding the details from the host operating system behind an object interface



- Work on object management system for SWD and demonstrate effectiveness using the emulated SWD