FTL

India vs SMI

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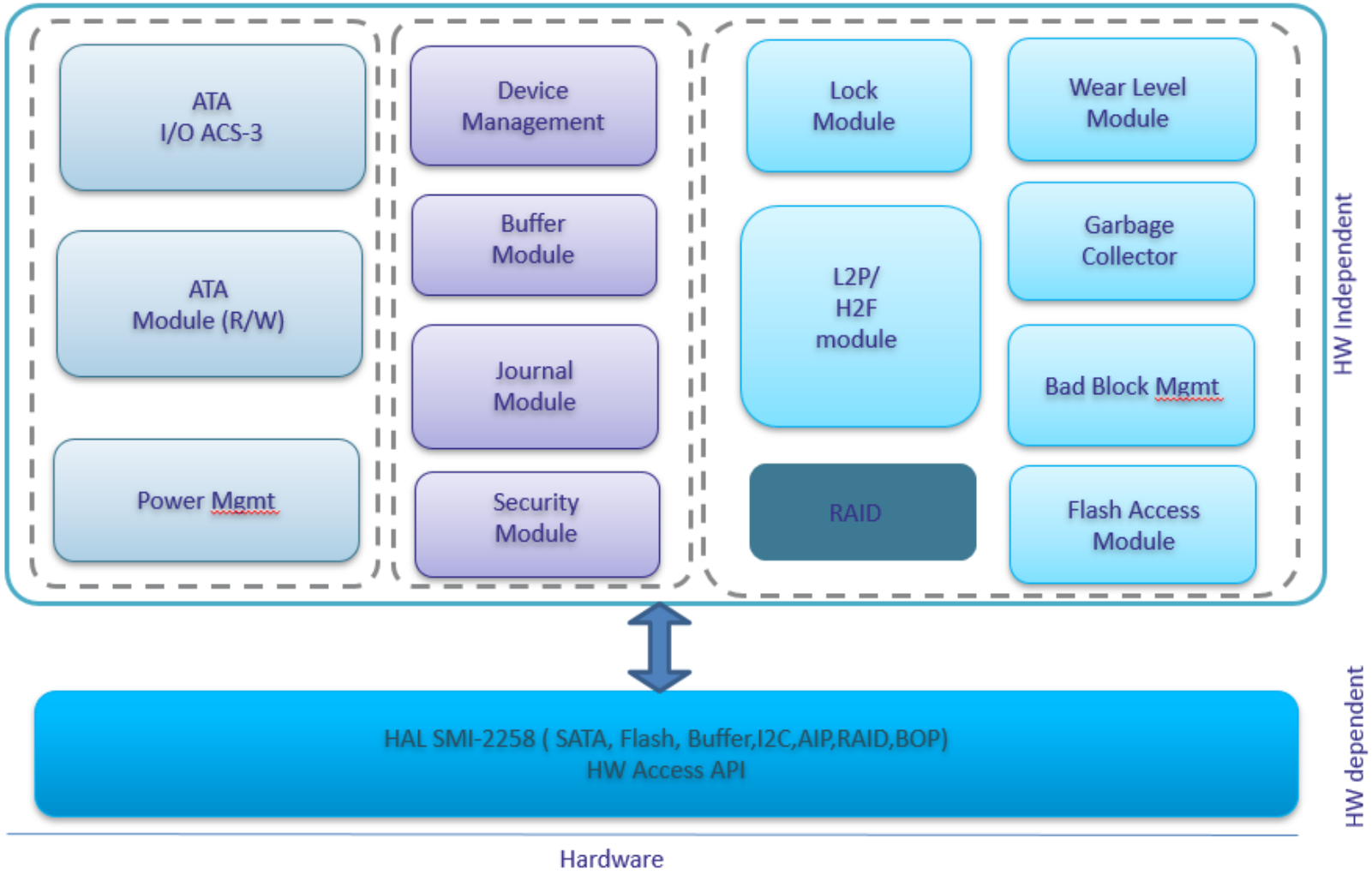
Overview

- **Architecture of India**
- **FTL Schema**
  - Logical address & Physical address
  - Table Recovery
    - Invert record
  - Swap Data
    - Garbage Collect, Wear Leveling, over ECC / bad block…
  - Performance
    - overlap
    - Memoization
- **SMI vs India**
  - L2P Table entry format
  - Block management
  - Invert table
  - Table write flow
  - Data flow
    - Host In
    - Swap data
- **Discuss (Q & A)**

Architecture of India

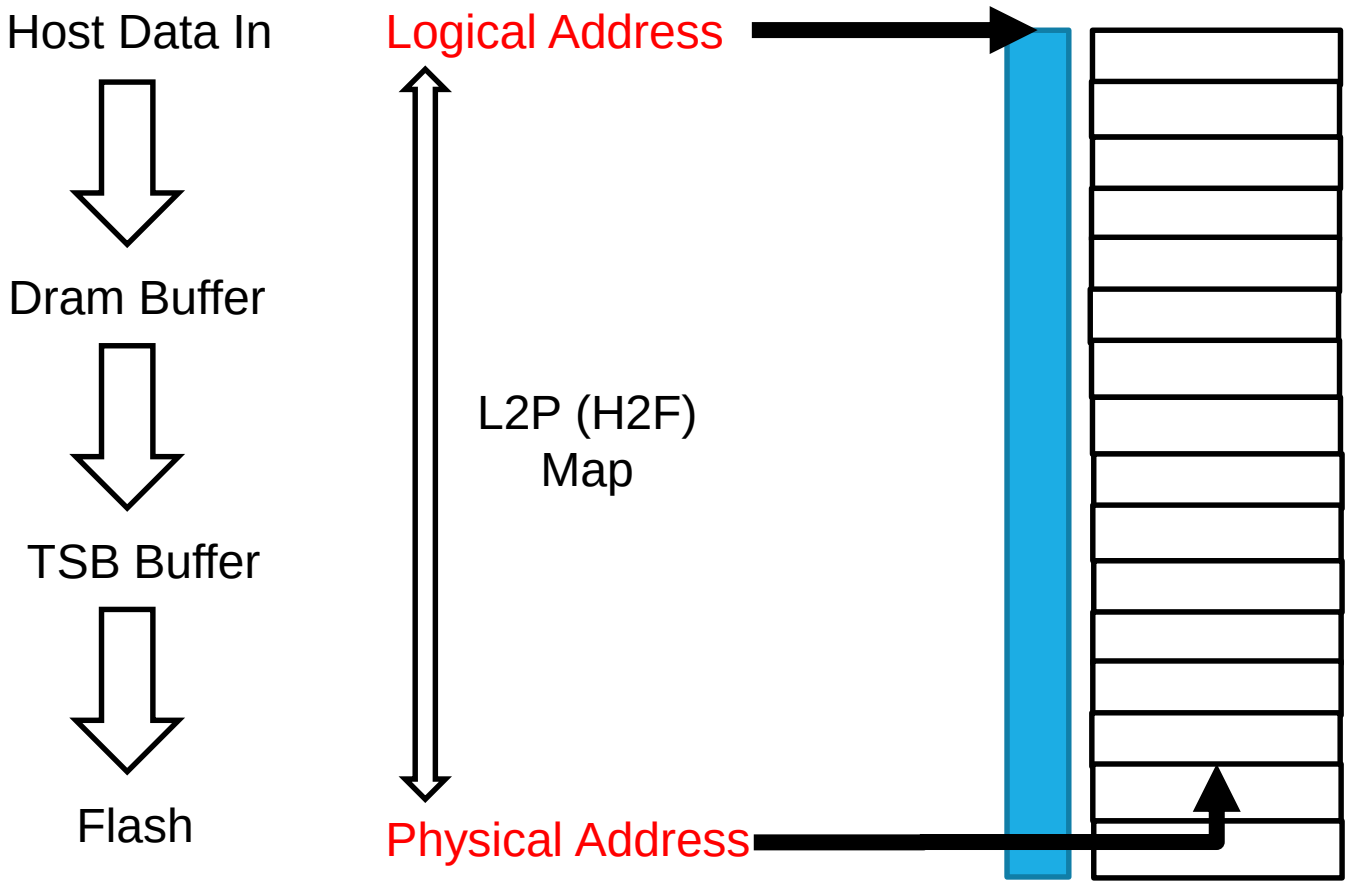
Architecture of India



FTL Schema

LBA Management (1)

- **Logical Address**
  - Host In address
  - H2F
  - L2P
- **Physical Address**
  - Flash Address
  - H2F
  - L2P



LBA Management (1)

- **Logical Address**
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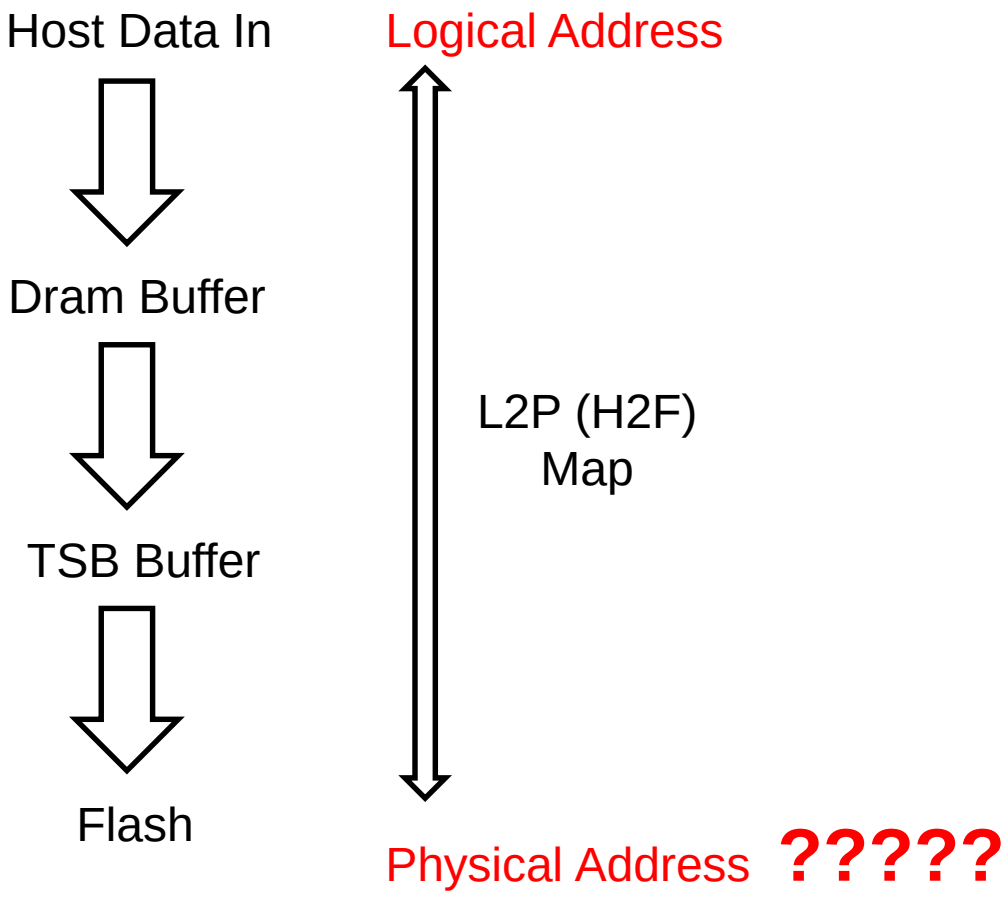
  - H2F
  - L2P
- **Physical Address**
  - Flash Address
  - H2F
  - L2P



LBA Management (2)

- **Middle Address**
  - For Firmware Management
  - Replacement
  - Super block

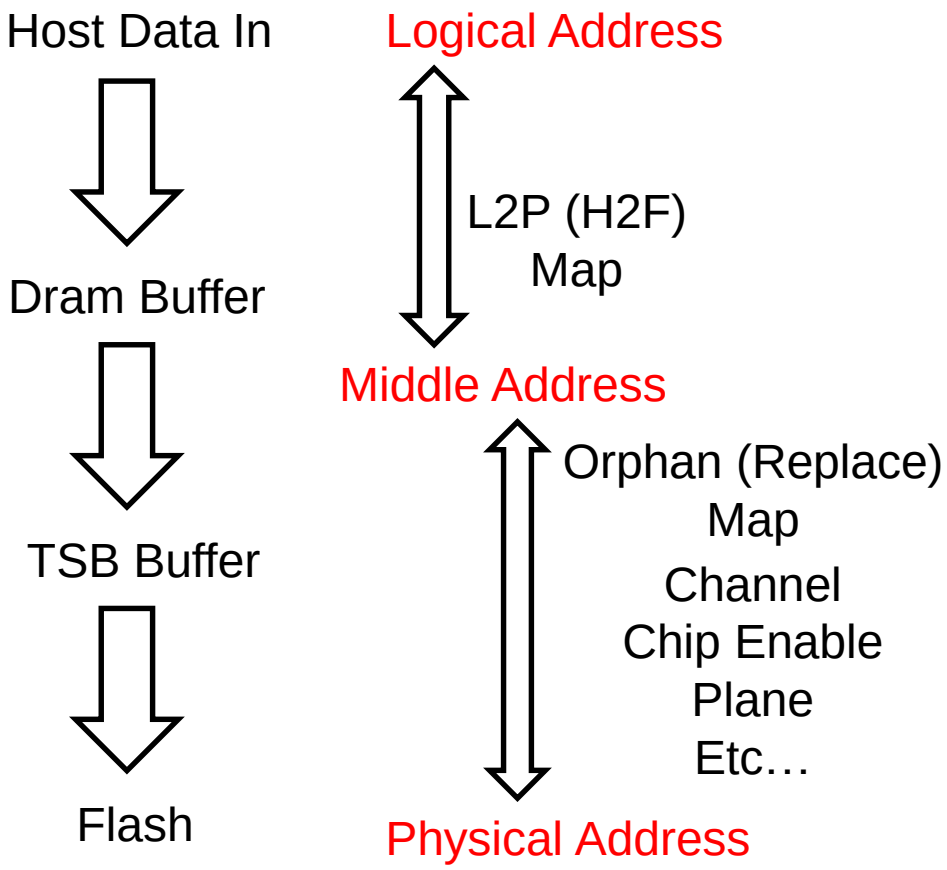
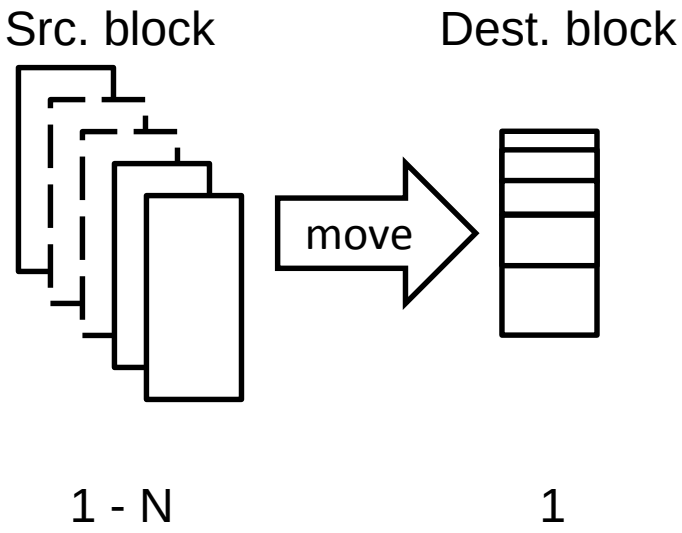


Table Recovery

- **Invert information**
  - Meta data
  - Sequence Number
    - block
    - host in
  - Finished tag
    - Used or unused
    - As T4 tag (Write Start/Stop)

Data Swap

- **Source Blocks : Destination Blocks**
  - 1-N : 1
- **Overhead**
  - Valid judgment
  - data move
  - flash active time
  - extra work
    - Table adjust



Performance

- **Overlap (Synchronize)**
  - DMA
  - Multi-core
  - Multi channel
  - Multi CE
  - Ping pong
  - Pipeline
- **Memoization**
  - Buffer
  - F2H
  - valid table

SMI vs India

L2P Table entry format

SMI

Type	Bit 31	Bit 30	Bit 29	Bit 28 – 16 (x)	Bit 15 (x) – 0
Dummy Page		1	1		
DRAM Source	UNC	1	0	Latest Cache Location (B)	Original Cache Location (P)
Flash Source	UNC	0	0	Block Address (B)	Unit Page Address (P)

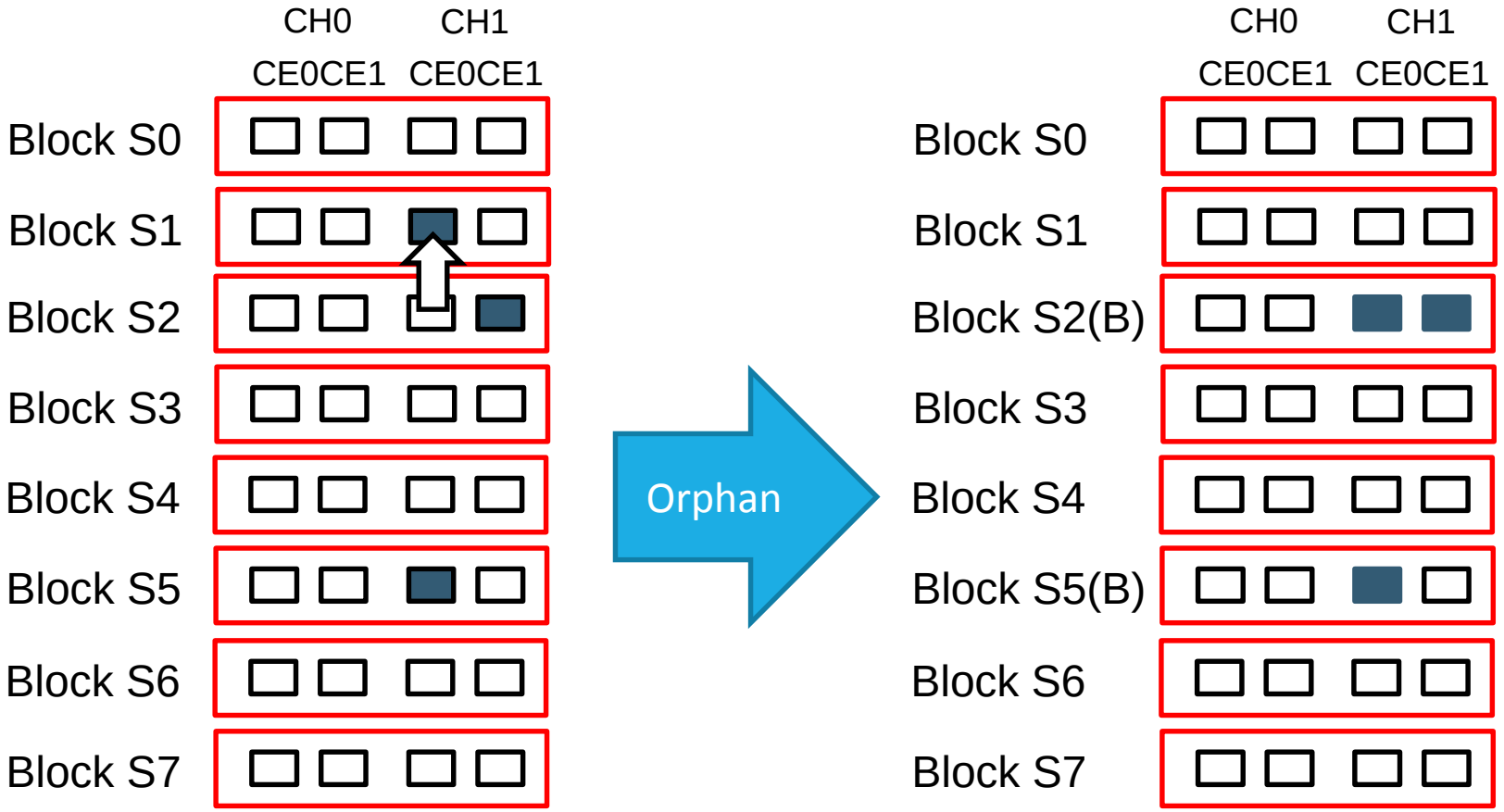
Middle Address

India

Type	Bit 31	Bit 30	Bit29	Bit 28	Bit 27 - 25	Bit 24	Bit 23	Bit 22 - 16	Bit 15 - 14	Bit 13 - 2	Bit 1 - 0
Lock Mode		1	F	Pf_w_idx					Buffer idx		
Entry Mode		0	Channel		target	lun	Plane	Block		Page	Pf

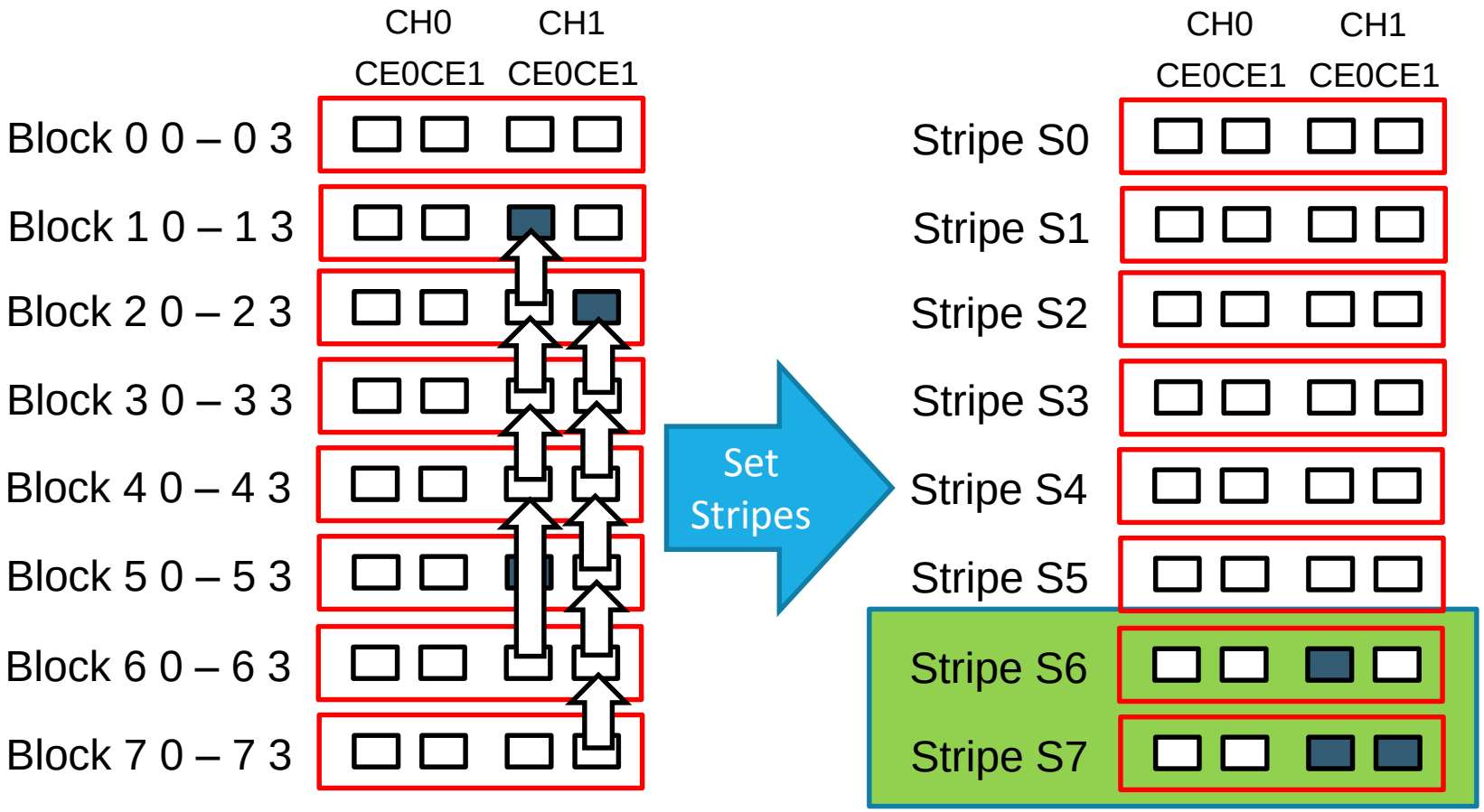
Block Management (1 SMI)

- **Super block**
- **Orphan table**
  - Plane replace
  - RTBB
    - Super block
    - Plane



Block Management (2 India)

- **Stripes**
  - Journal (Static)
  - Data (Dynamic)
- **No block combination**
- **No replacement**



Invert Table

- **Meta (Spare data)**
  - SMI
    - F2H
    - EOB
  - India
    - Snapshot

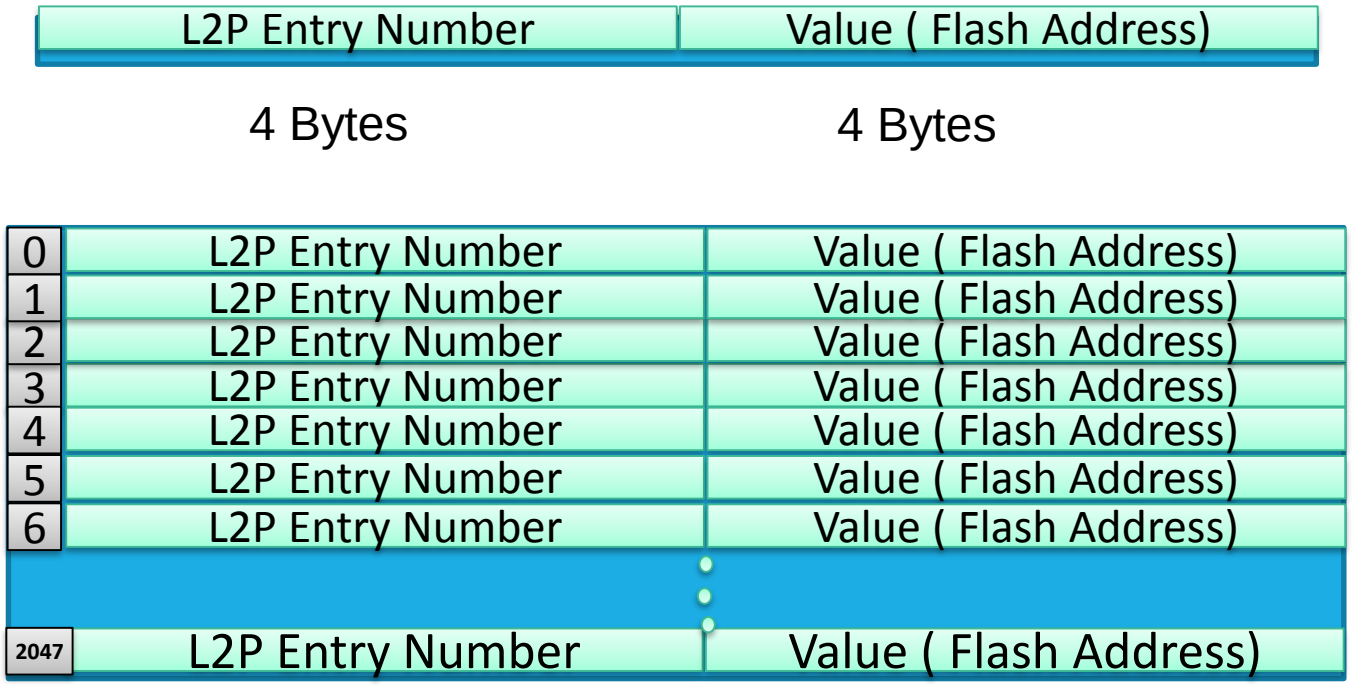


Table write flow (1)

- **SMI**
  - EOB
    - F2H
    - Erase count
  - Map
    - L2P (H2F): Diff
    - G2F
  - Map block Infor
  - Infor Block
    - Valid count
  - Index Block

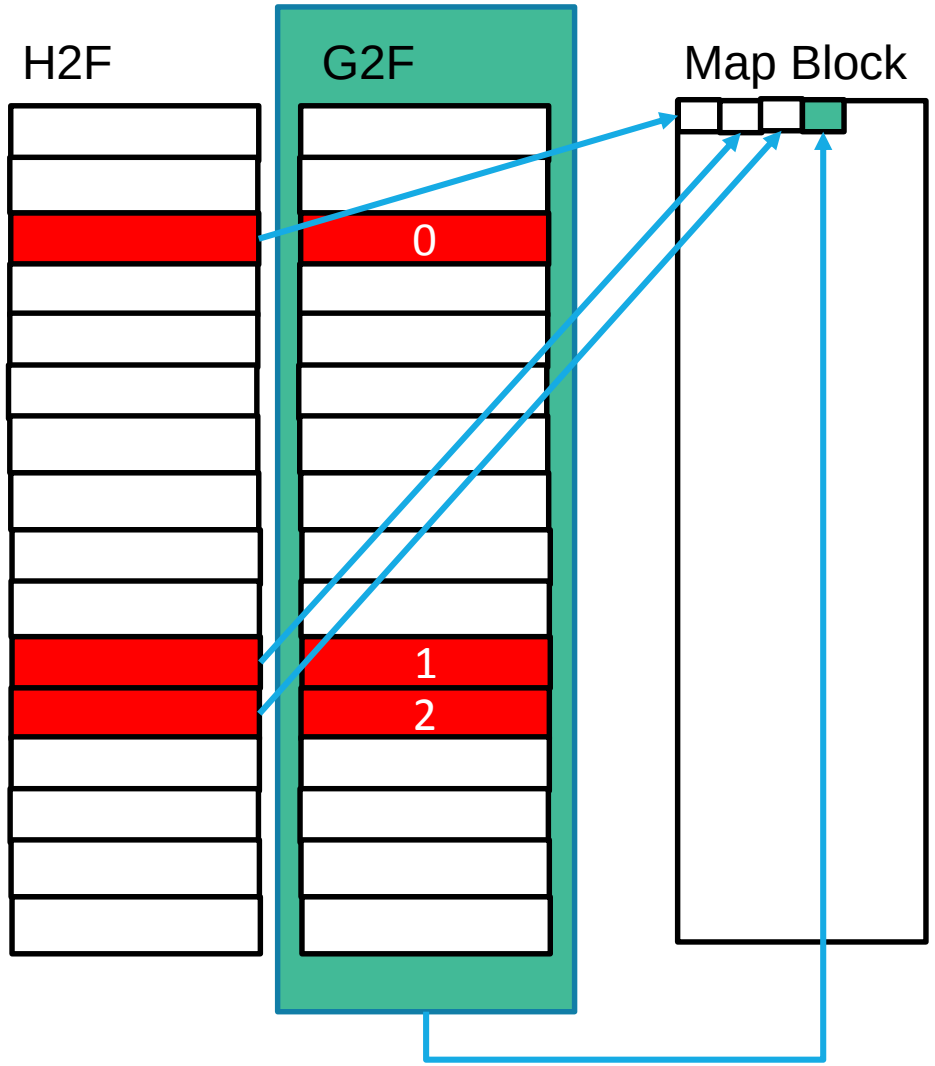
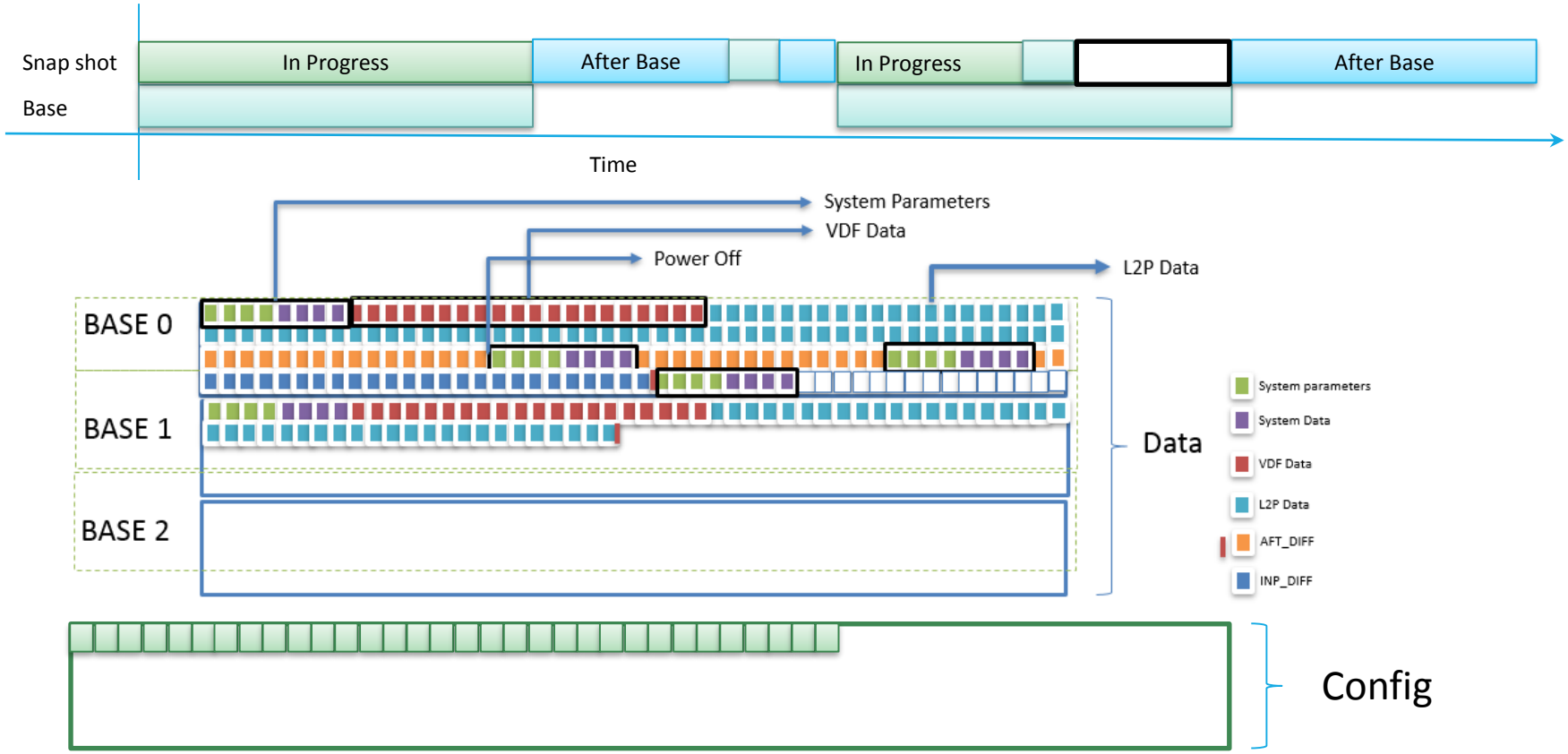


Table write flow (2)

```
typedef enum
{
        SYSTEM_PARAMS=0x0,
        SYSTEM_DATA,
        VDF_DATA,           // Valid data frame bitmap.
        L2P_TABLE_DATA,     // Logical to physical table.
        L2P_INDIFF_START,   // L2P Diff Snaps in base open pogress
        L2P_ADIFF_START,    // L2P Difference After Base close update
        CONFIG_DATA
}snapshot_data_type_e;
```

Journal Module Components

- BASE
  - System Parameters
  - System Data
  - VDF Data (P)
  - L2P Data (P)
  - Partial write
    - In base open progress
- SNAP SHOT
  - Base in Progress.
  - After Base Write
- Config
  - Base and Snap info

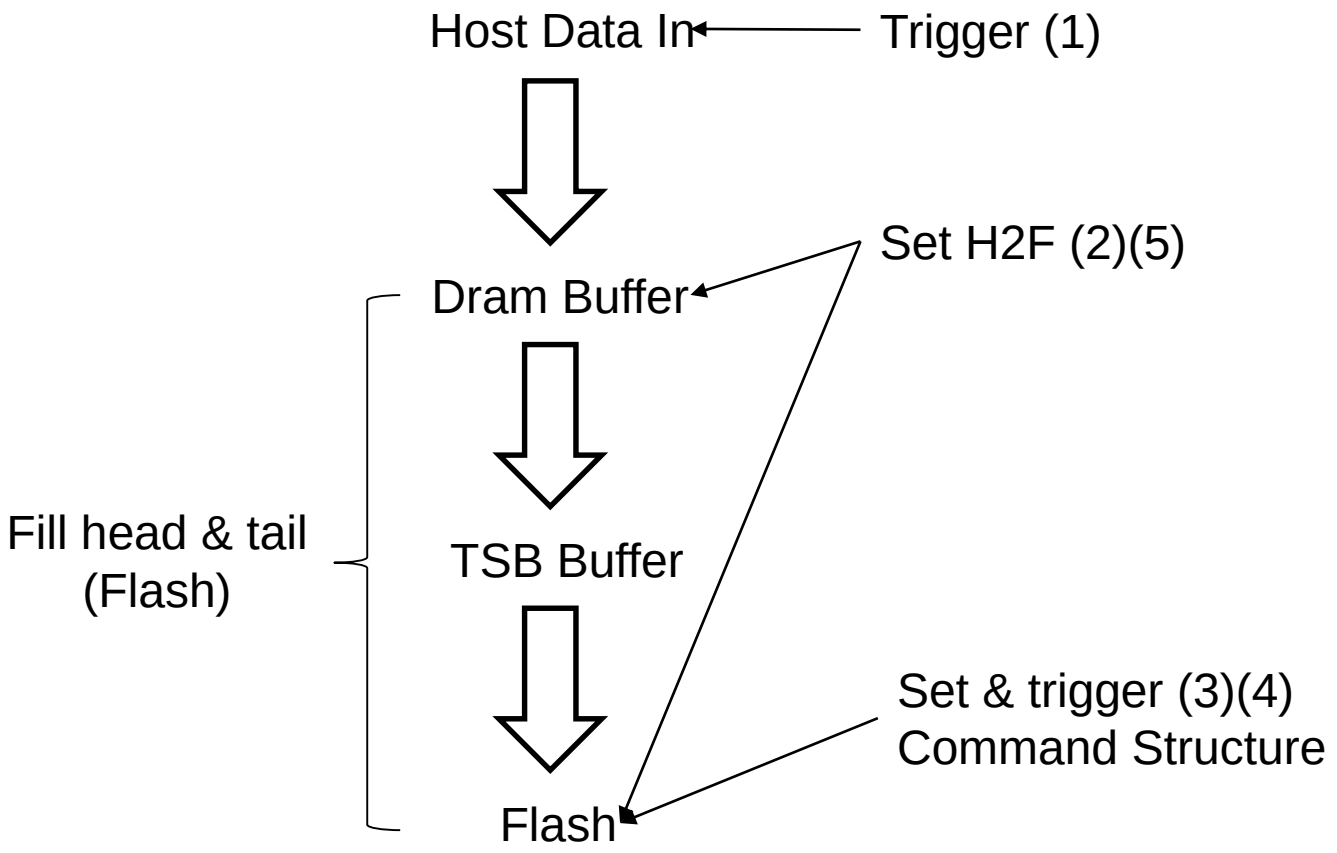


Write unit

- **Super page (SMI)**
  - > 1.5 super page trigger
    - Length
  - Collect valid unit
  - Write to flash
- **Stripe (India)**
  - Equal active target size (SLC/TLC)
    - Valid count
  - Write to flash

Write flow (1)

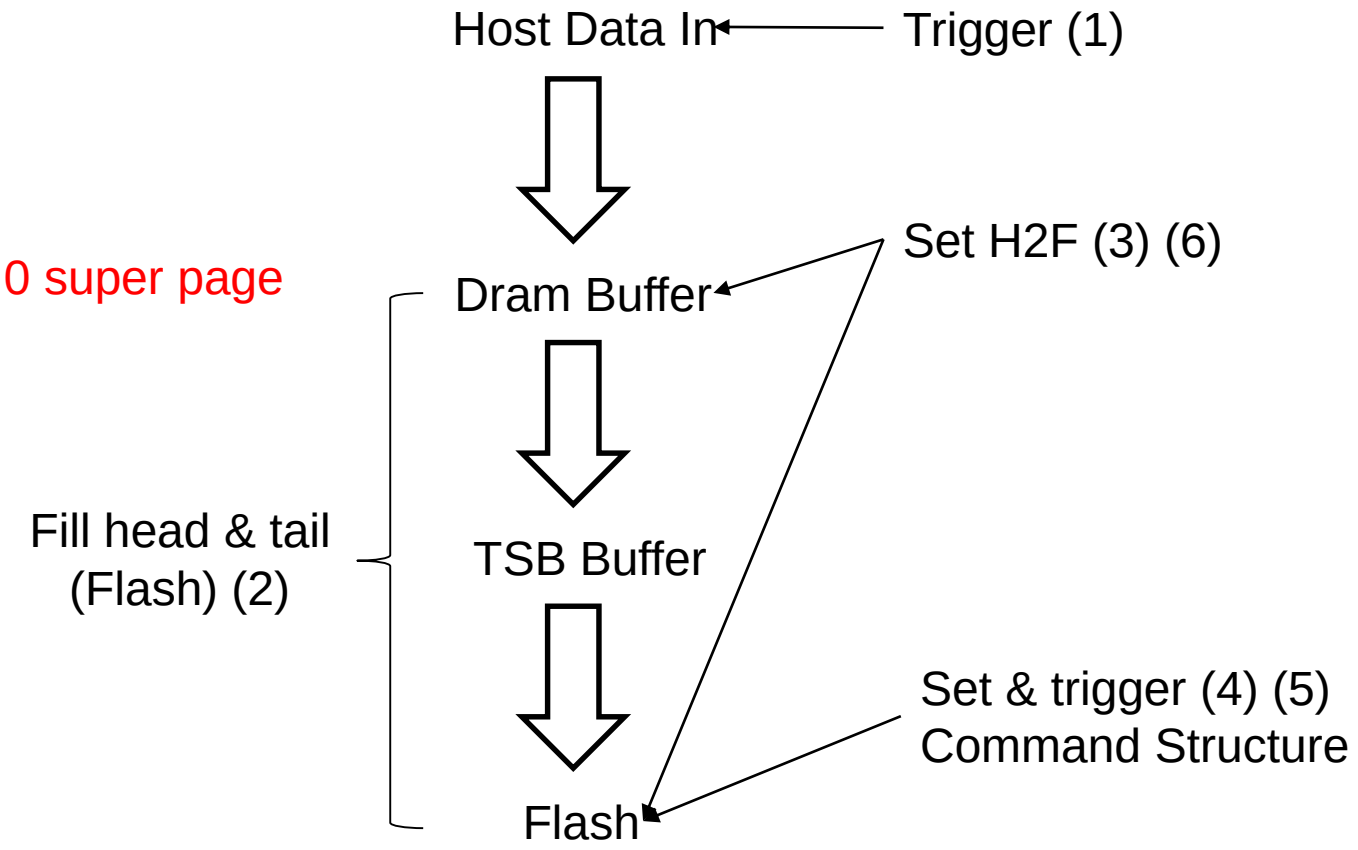
- **Trigger to Dram**
- **Set H2F (DRAM)**
- **Fill head & tail**
  - 4K align
  - Read/Move from source
- **Set multi-write command**
- **Set H2F (Flash)**
- **Write to flash (flash service)**



Write flow (2 SMI)

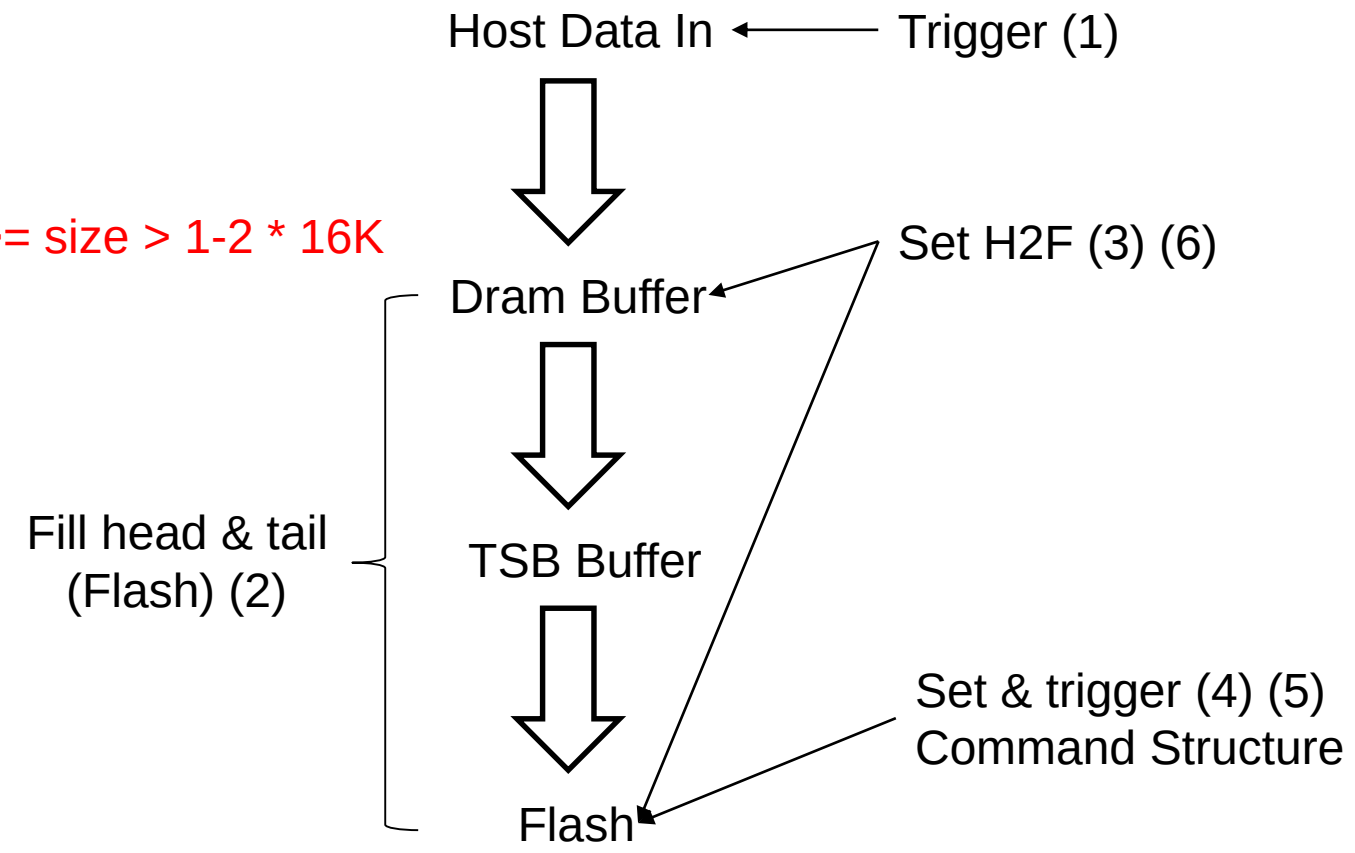
- Trigger to Dram
- Set H2F (DRAM)
- Fill head & tail
  - 4K align
  - Read/Move from source
- Set multi-write command
- Set H2F (Flash)
- Write to flash (flash service)

size > 1.5-2.0 super page



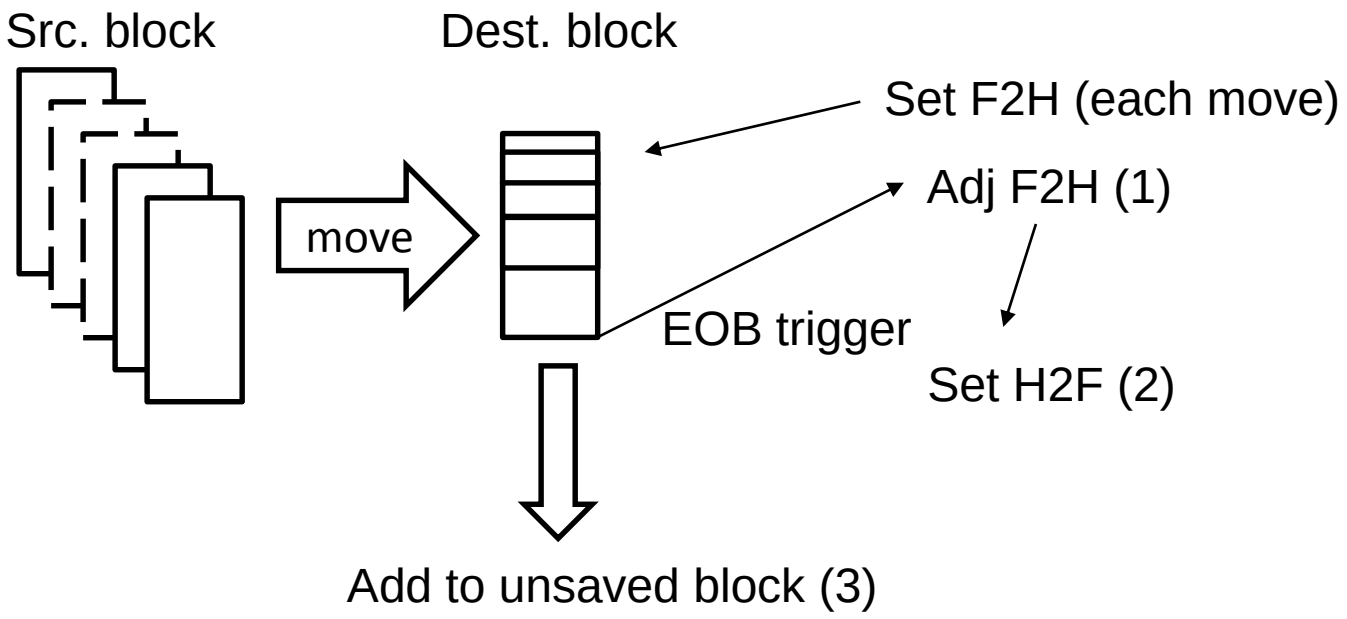
Write flow (3 ATP India)

- Trigger to Dram
- Set H2F (DRAM)
- Fill head & tail ⇐ 2 * Super >= size > 1-2 * 16K
  - 4K align
  - Read/Move from source
- Set multi-write command
- Set H2F (Flash)
- Write to flash (flash service)



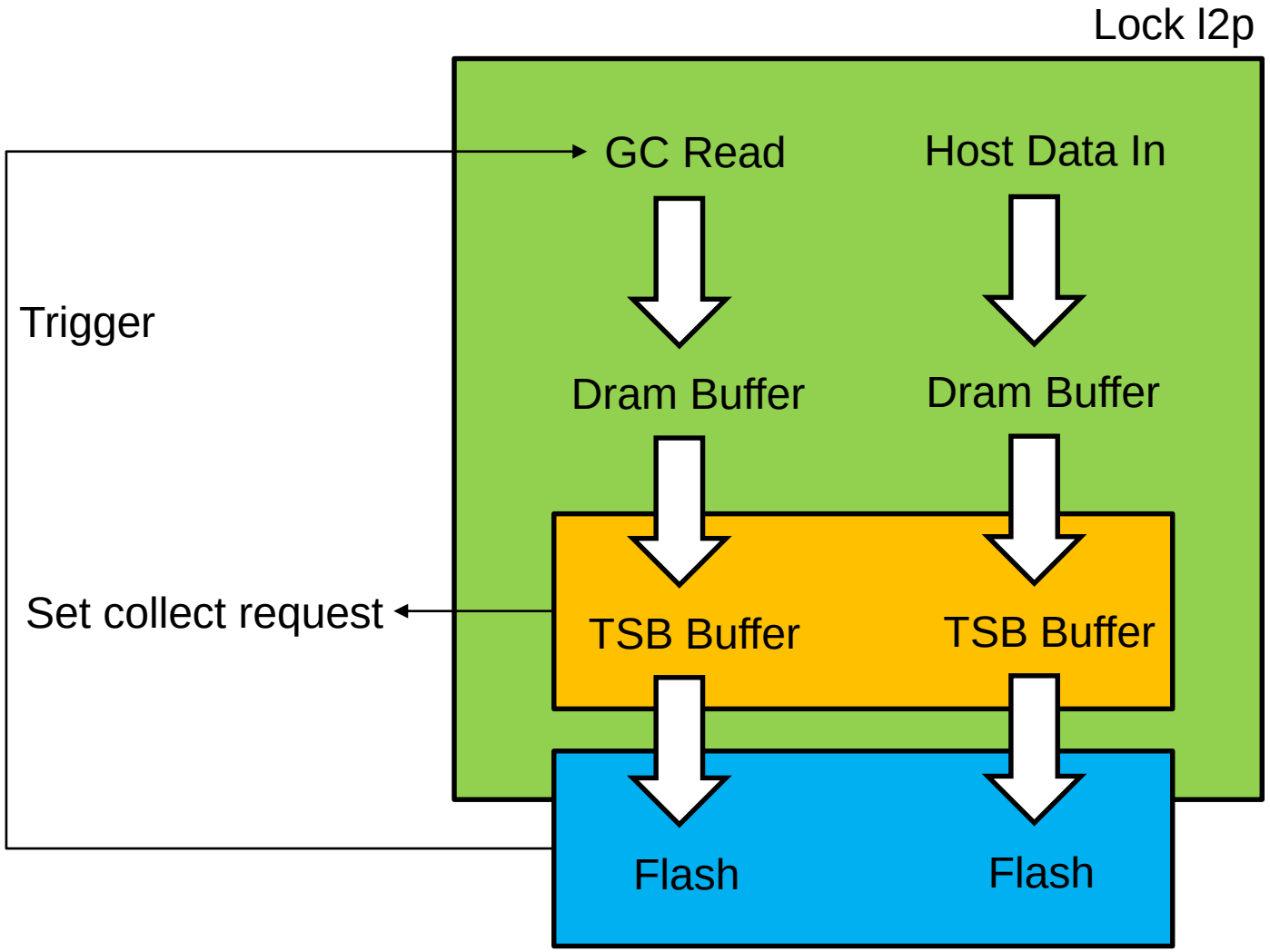
Data Swap (SMI)

- **Each super page write**
  - Partial Collect
- **Valid Group**
  - F2H => H2F
    - F2H ⇔ H2F (valid)
    - invalid
  - H2F => F2H
    - F2H ⇔ H2F (valid)
    - Error
- **GC Finished**



Data Swap (India)

- **Each collect write back**
  - Host In
  - GC Collect
- **Set GC collect request**
- **Collect Read**
  - Trigger by flash r/w request
- **Valid Group**
  - Valid group table



Lock module

- **Consistency**
- **L2P lock**
  - Partial read
    - head
    - tail
- **DBuffer lock**
- **RBuffer lock**
- **Flash lock**

Q & A

Discuss

- **Multi dimension L2P**
  - 在什麼狀況下需要以多維陣列呈現 ??
- **Orphan Table Adjust**
  - 調整的替換來源, 以及影響??
- **Stripe**
  - 討論Stripe
- **Snapshot vs F2H**
  - 限制?? 優缺??
- **Other**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