

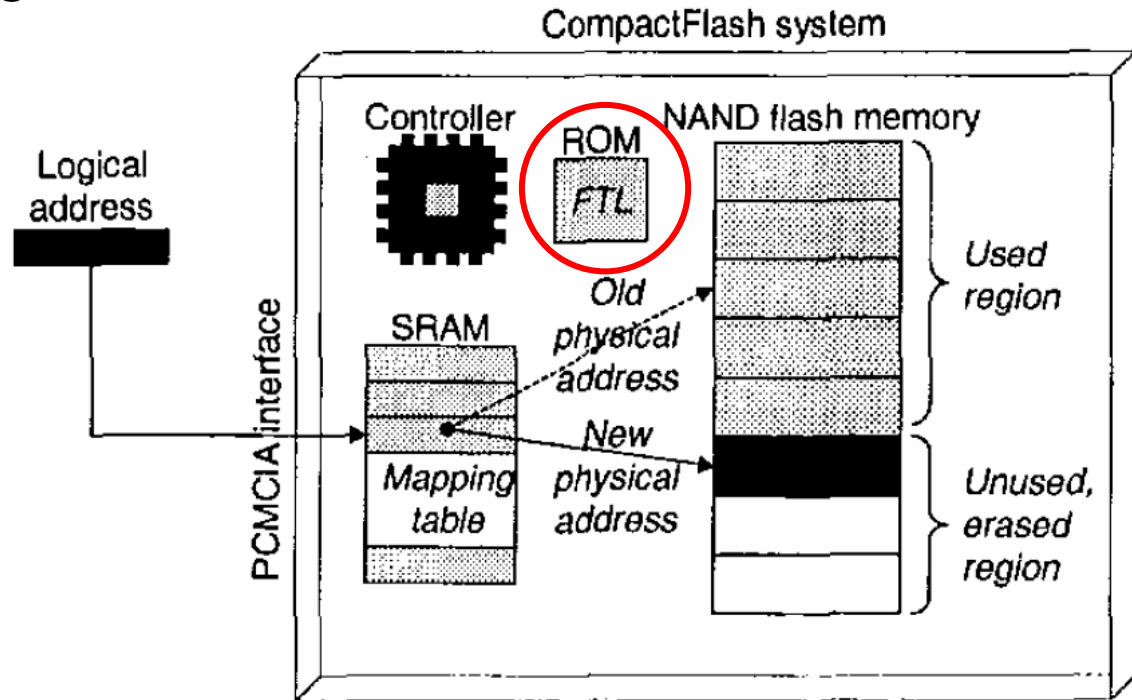


# FTL (Flash Translation Layer)

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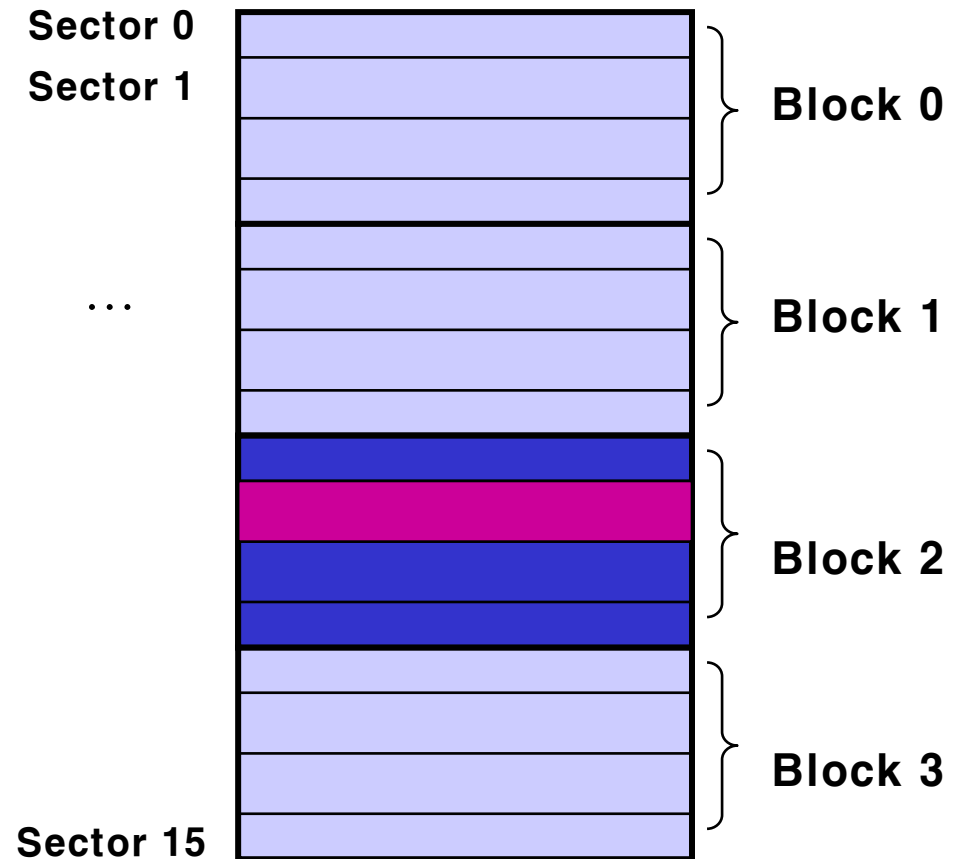
# FTL

- Functionalities of FTL
  - Logical to physical address mapping
  - Power-off recovery
  - Wear-leveling



# Why FTL is Necessary ?

- Two features of flash memory
  1. “Erase before write” architecture
  2. The erase size (Block) is not same to the read/write size (sector)



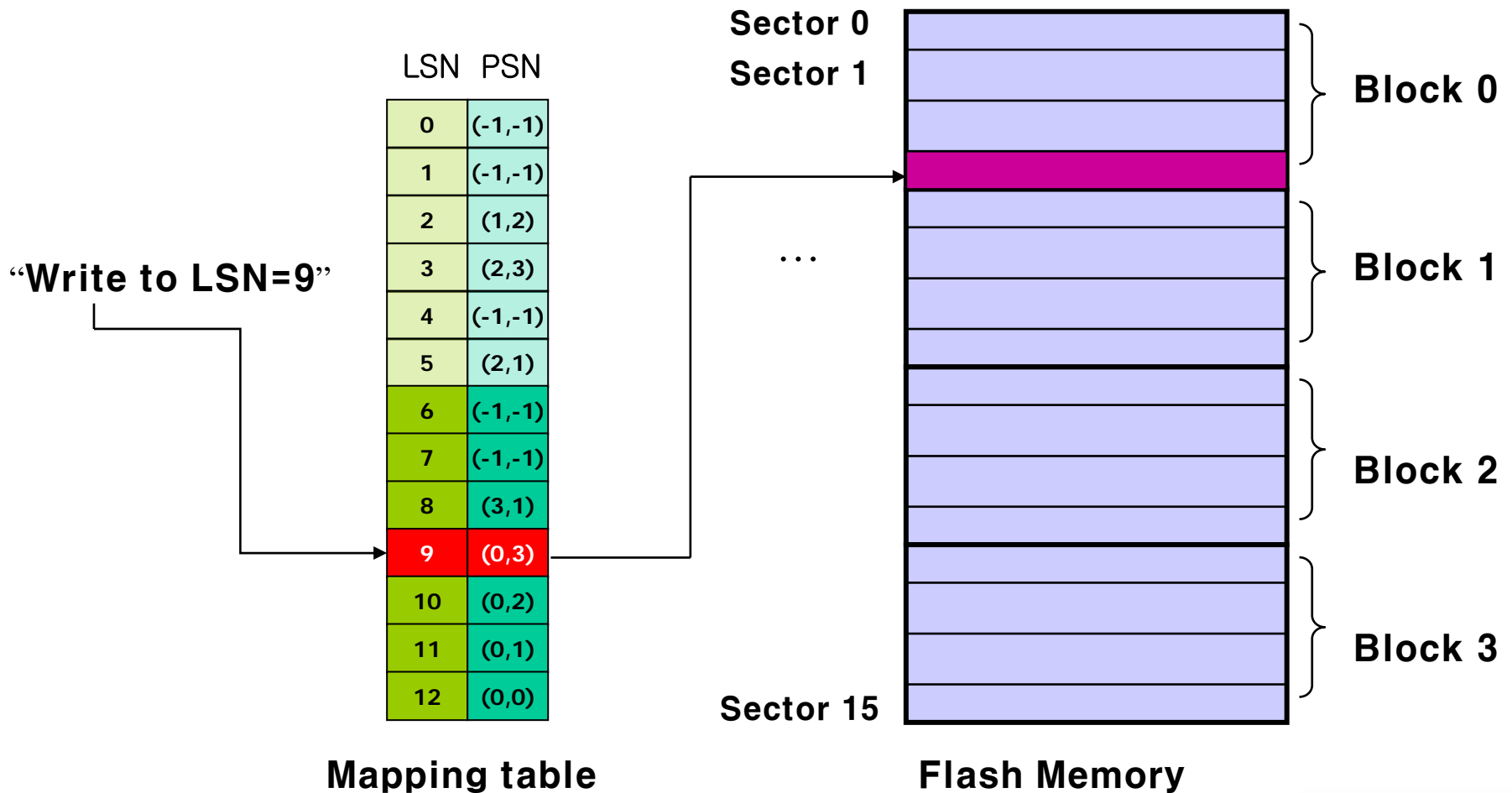
# Basic FTL

- Mapping Methods
  - Sector Mapping
  - Block Mapping
  - Hybrid Mapping
- Managing Address Mapping Information
  - Map Block Method
  - Per Block Method

# Sector Mapping

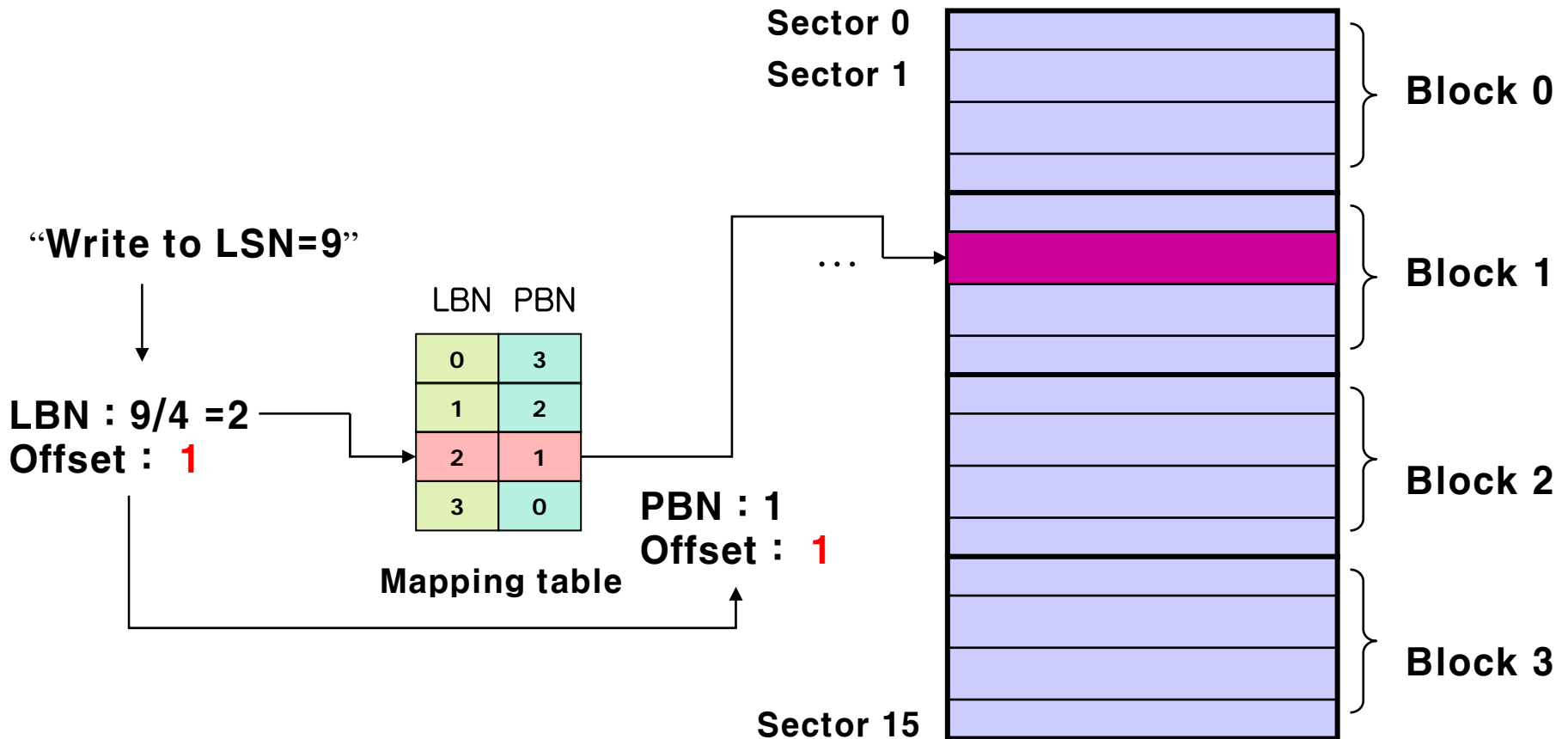
LSN: Logical Sector Number

PSN : Physical Sector Number



# Block Mapping

LBN: Logical Block Number  
PBN : Physical Block Number



# Hybrid Mapping

“Write to LSN=9”

↓  
LBN :  $9/4 = 2$   
Offset : **read  
spare area,  
and find next  
free sector**

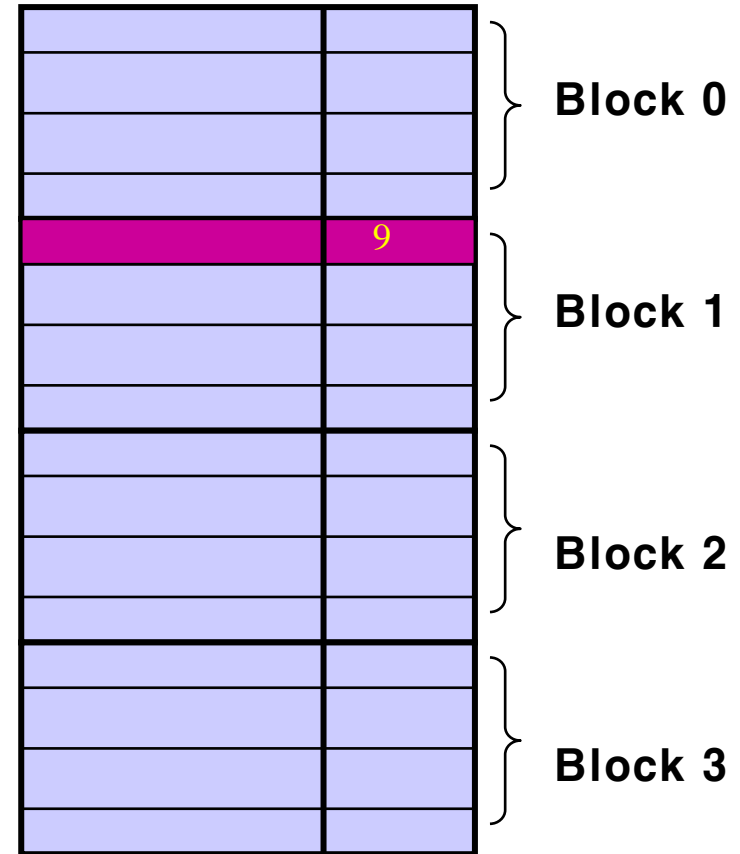
LBN	PBN
0	3
1	2
2	1
3	0

Mapping table

→ ...  
PBN : 1  
LSN : 9

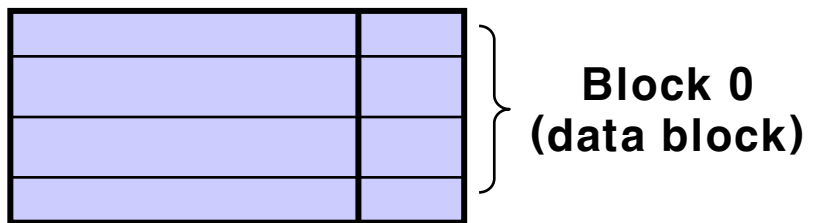
Sector 0  
Sector 1

Sector 15

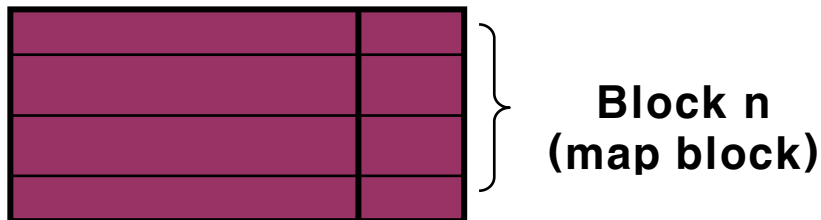


# Managing Address Map Information

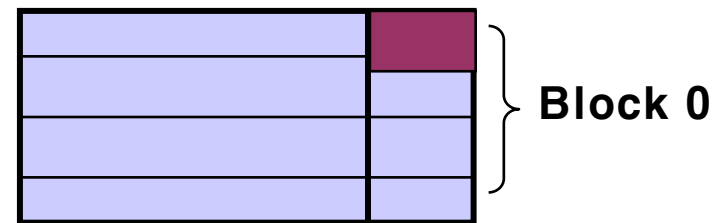
- Information
  - Mapping address (from logical address to physical address)
  - State of space (valid, invalid, free)
  - Write count (for wear-leveling)
  - Etc.



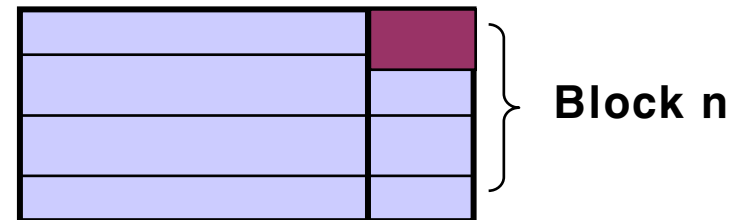
...



Map block Method



...



Per block Method

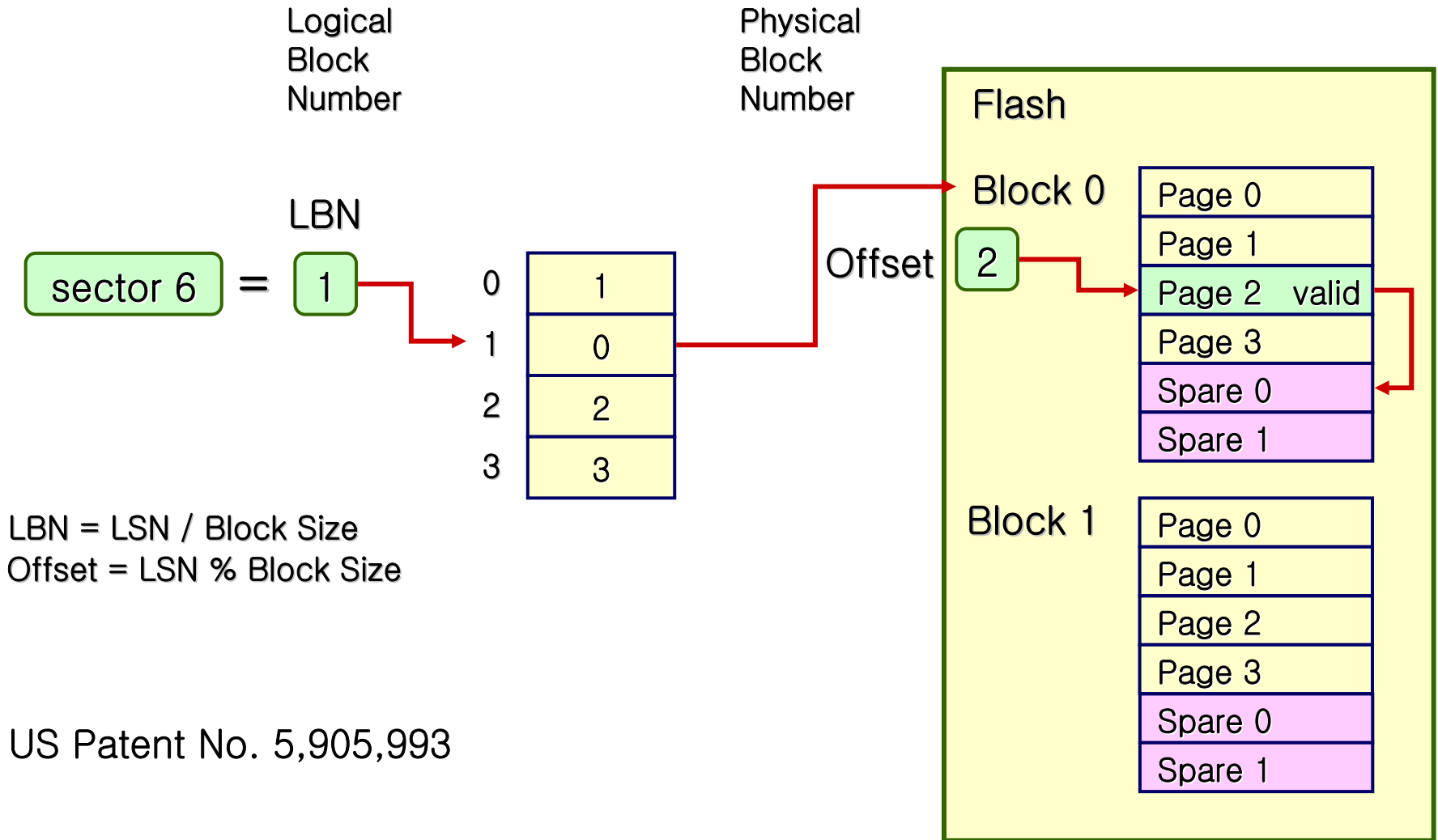




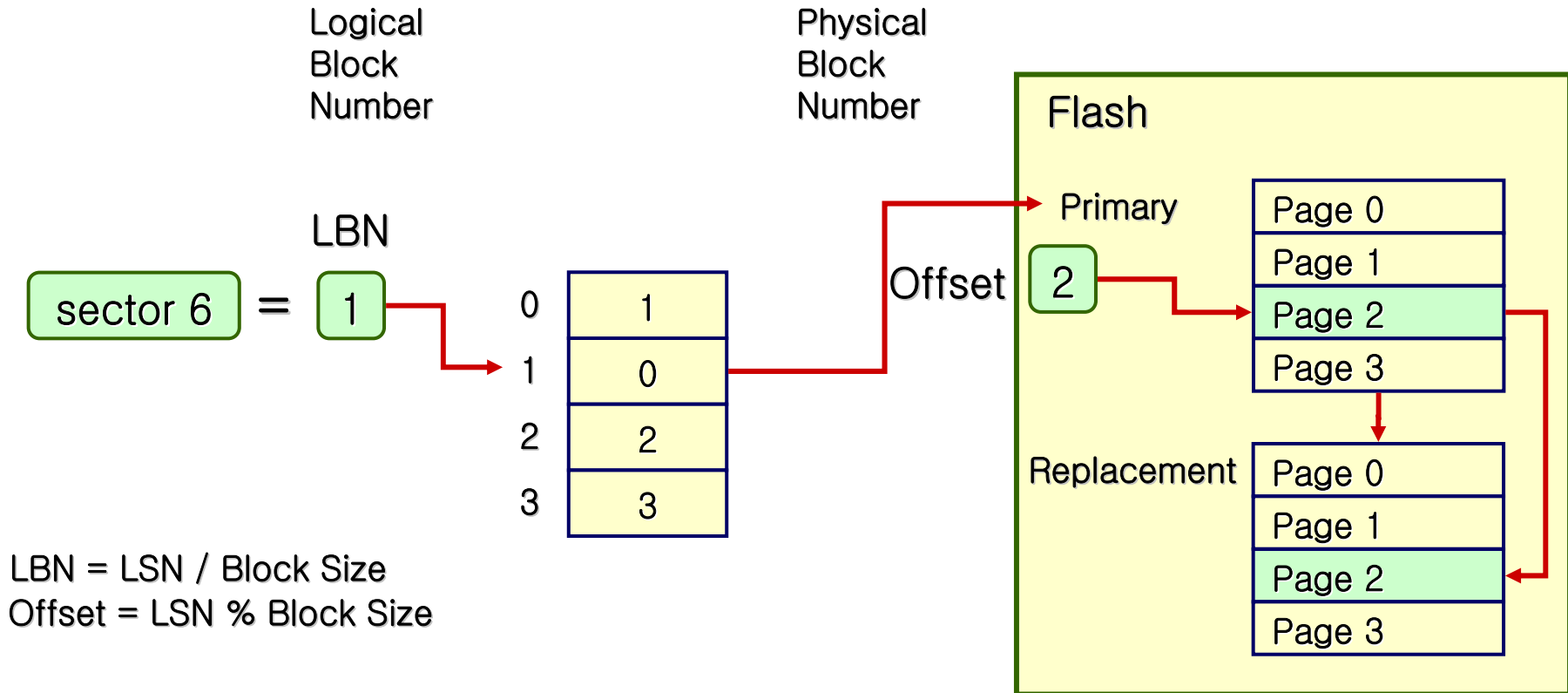
# Case Study

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# Mitsubishi



# M-Systems



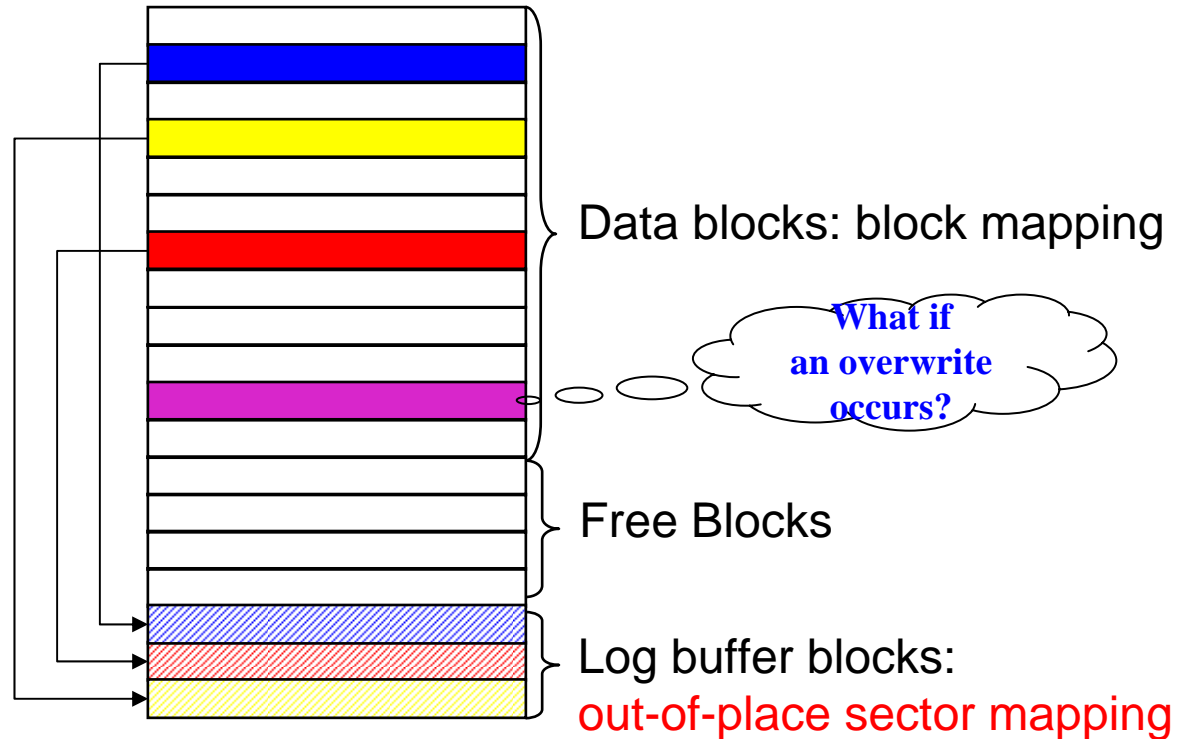
US Patent No. 5,937,425/5,404,485

FMAX) Logical Block : Physical Block = 1 : 2

ANAND) Logical Block : Physical Block = 1 : N

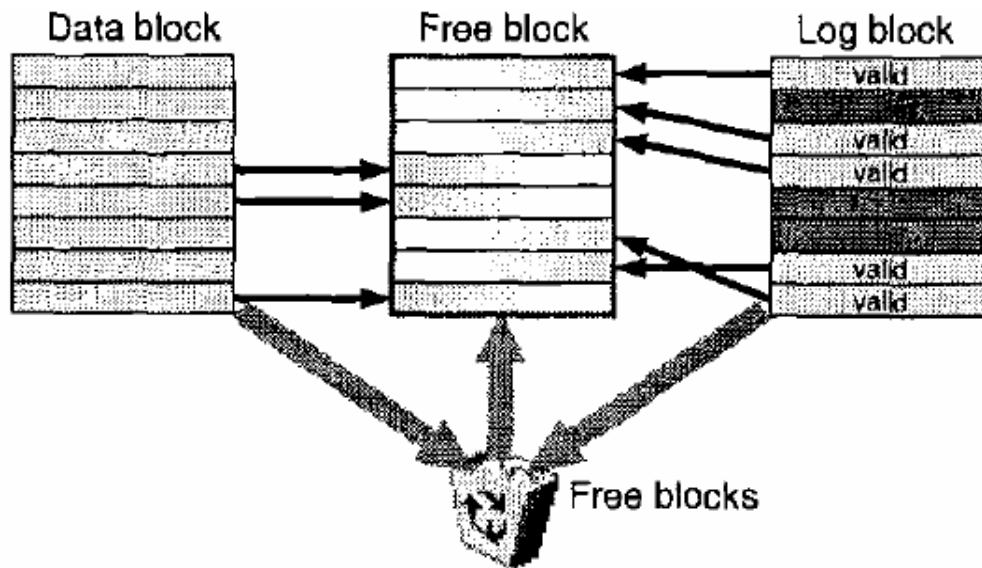
# SNL-FTL (Log-based Scheme)

1. For each sector overwrite in a data block, the overwrite is directed to a corresponding log buffer block, if assigned. (e.g. normal line)
2. For overwrites of a data block without its log buffer block, one log buffer is replaced out and a new log buffer is assigned to the data block.
  - The victim log block should be **merged** with its data block

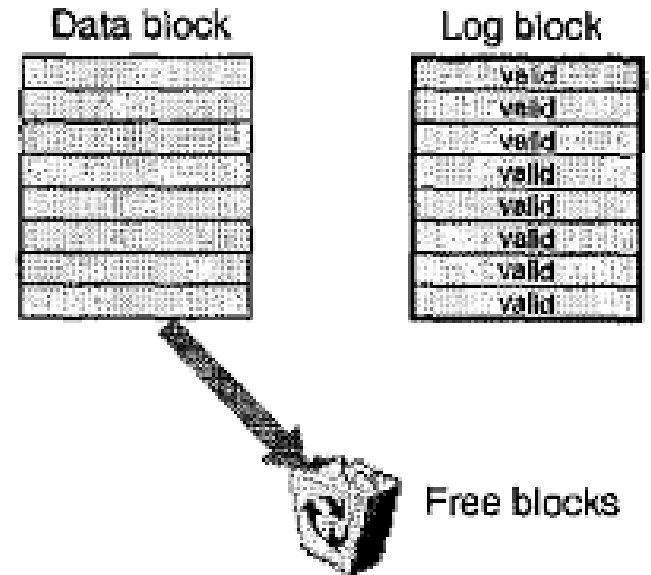


Jesung Kim et al., "A Space-Efficient Flash Translation Layer for CompactFlash Systems",  
IEEE Transactions on Consumer Electronics, Vol. 48, No. 2, May 2002

# SNL-FTL (2)



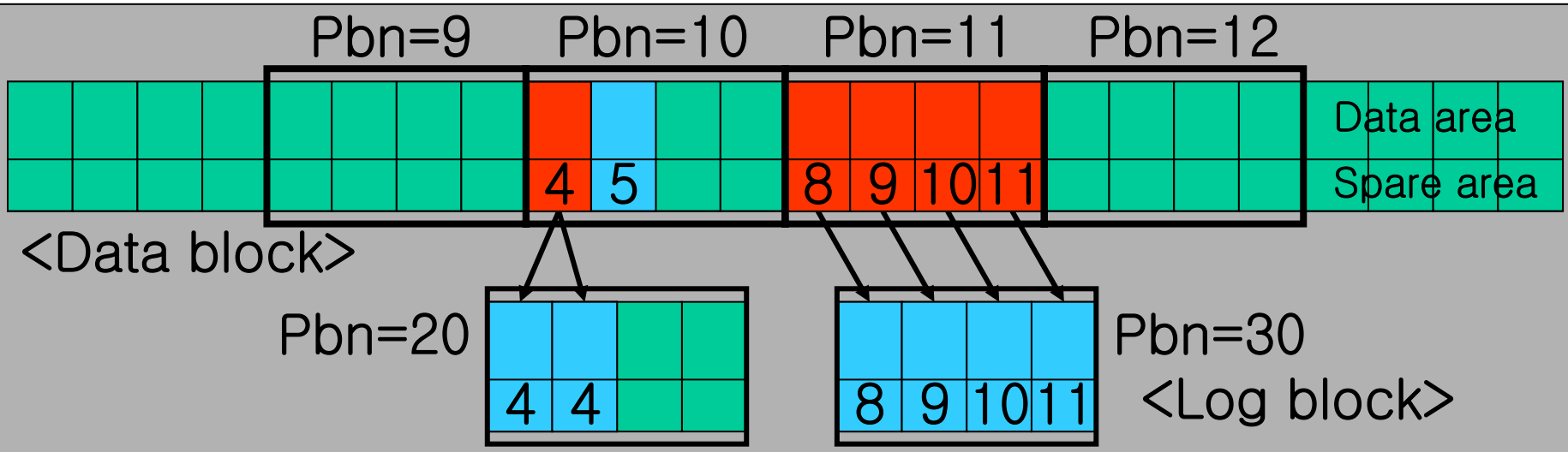
(a) Log block Merge



(b) Log block Switch

# SNU-FTL

4	5	4	4	8	9	10	11	8	9	10	11
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lbn	pbn
0	5
1	10
2	11

Block mapping table

lbn	pbn	lsn
1	20	{4, 4}
2	30	{8, 9, 10, 11}

Sector mapping table for log block