Project #1: NAND Simulator

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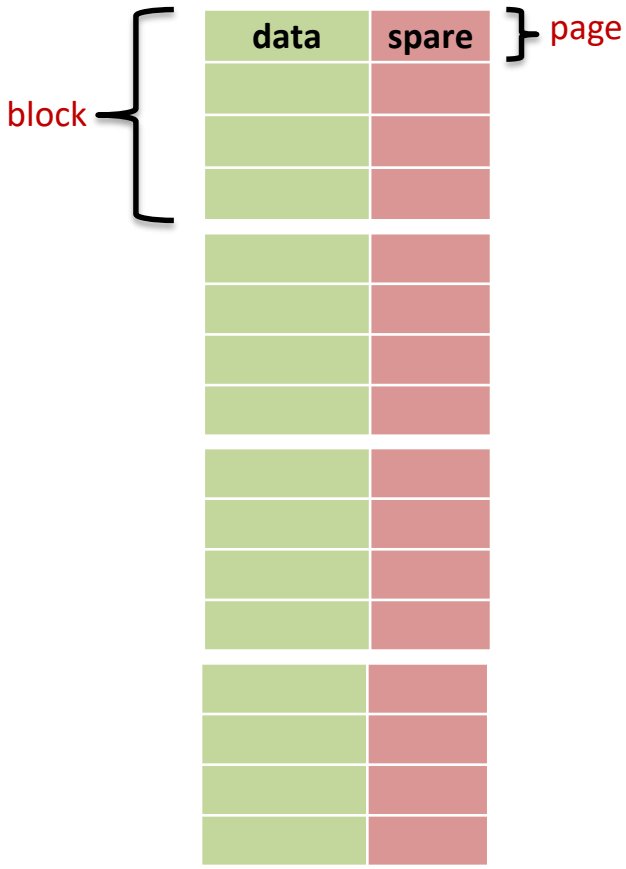
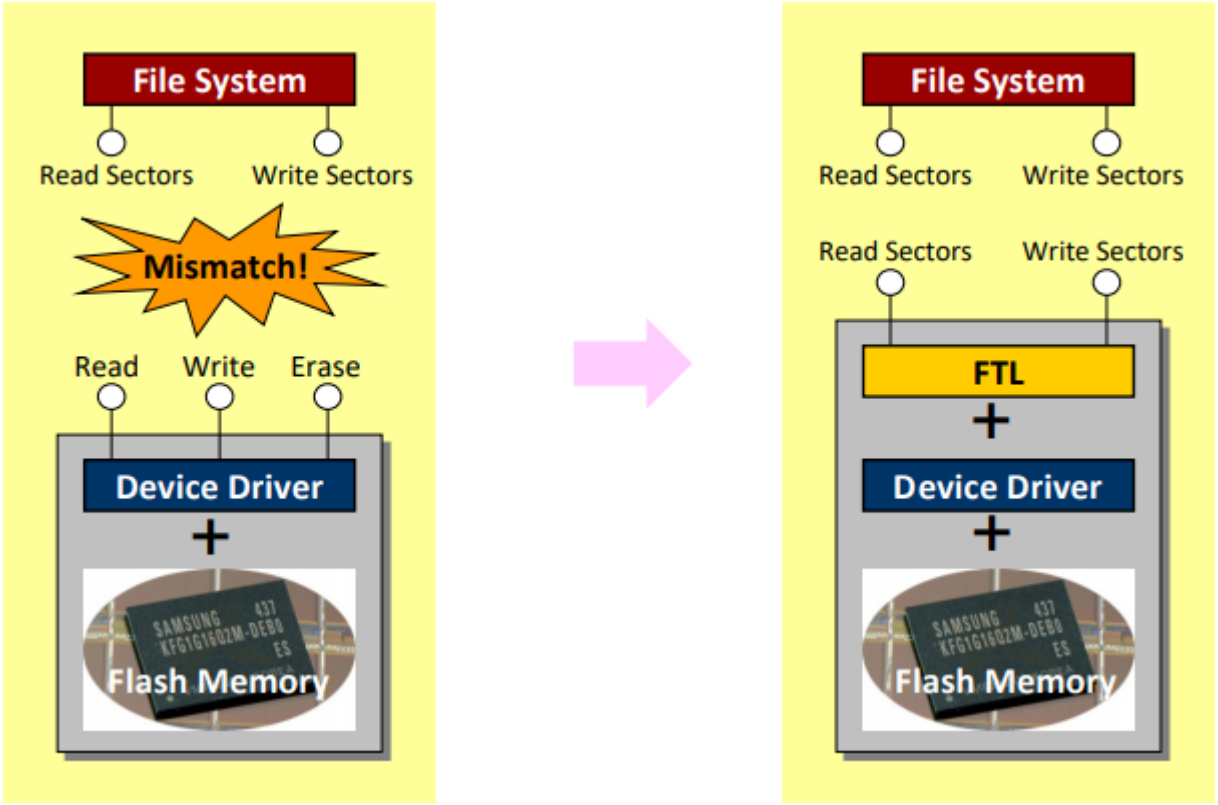
NAND Flash Memory

- Erase-before-write
- Bulk erase
  - Program unit: page
  - Erase unit: block
- Sequential write in a block



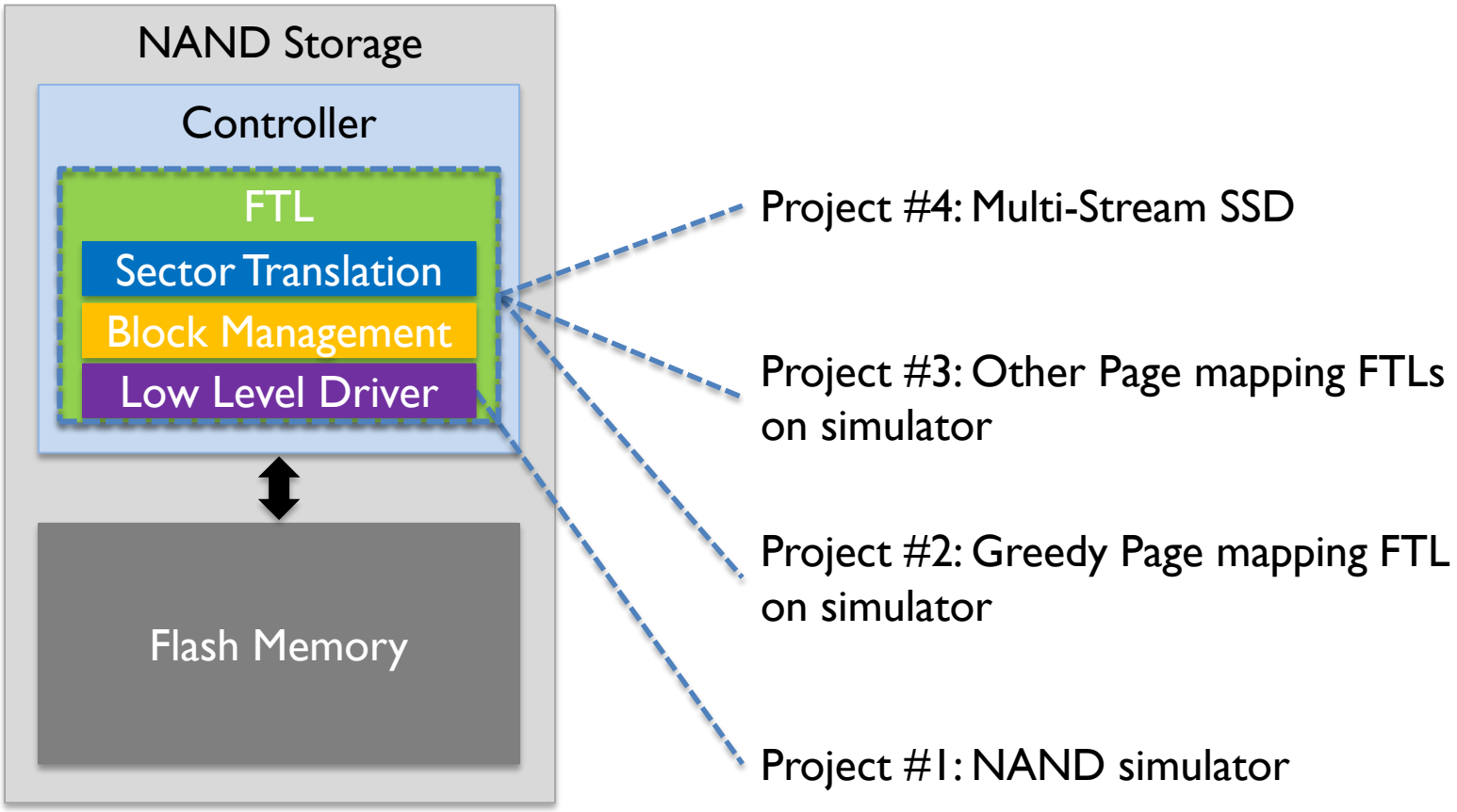
Flash Translation Layer

- A software layer to make NAND flash fully emulate traditional block devices



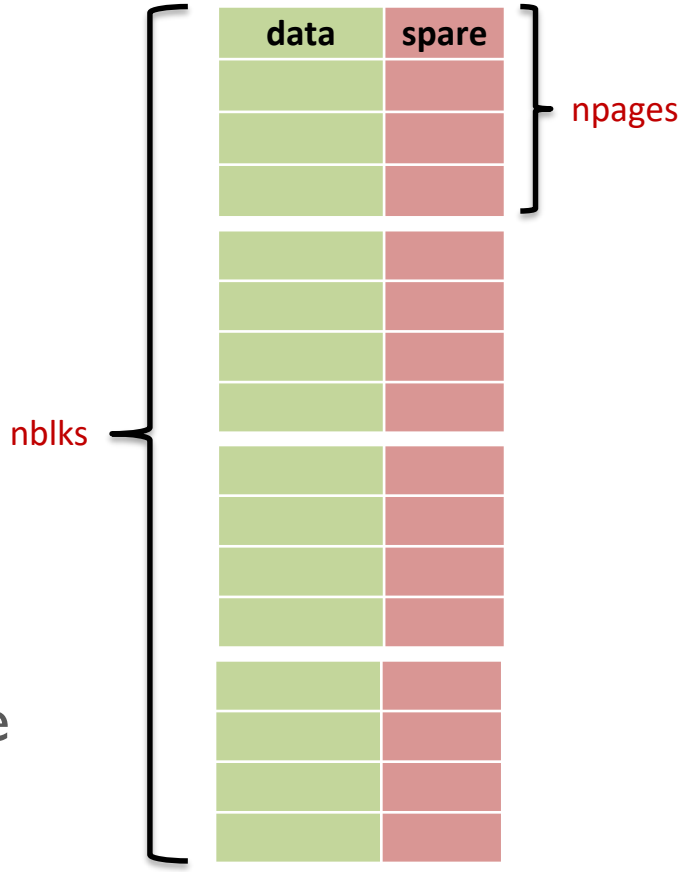
Source: Zeen Info. Tech.

Project Outline (without board)



Project 1

- Develop a NAND simulator
  - Simulate NAND flash memory using host DRAM
  - 4B for data / 4B for spare
  - Functions to implement:
    - nand_init()
    - nand_read()
    - nand_write()
    - nand_erase()
    - nand_blkdump()
  - The skeleton code is available at course homepage



nand_init()

- nand_init(*nblks*, *npages*)
  - Description
    - Initialize your own NAND flash memory using DRAM
    - Initial state of the flash memory is 'all-blks-erased'
    - If success, print initialized information of the flash memory
    - If not, print appropriate error message (reason for the error)
  - Argument
    - nblks : the total # of blocks (should be > 0)
    - npages : # of pages per block (should be > 0)
  - Return value
    - Return 0 on success
    - Return -1 on errors

nand_write()

- nand_write(*blk, page, data, spare*)
  - Description
    - Write 'data' and 'spare' to the memory pointed by 'blk' and 'page'
    - If success, print written data and spare
    - If not, print appropriate error message (reason for the error)
  - Argument
    - blk, page : address of the flash memory
    - data, spare : data to store
  - Return value
    - Return 0 on success
    - Return -1 on errors

nand_read()

- nand_read(*blk*, *page*, *data*, *spare*)
  - Description
    - Read 'data' and 'spare' from the memory pointed by 'blk' and 'page'
    - If success, print read data and spare
    - If not, print appropriate error message (reason for the error)
  - Argument
    - blk, page : address of the flash memory
    - data, spare : data to load
  - Return value
    - Return 0 on success
    - Return -1 on errors

nand_erase()

- nand_erase(*blk*)
  - Description
    - Erase the NAND memory block 'blk'
    - If success, print appropriate message with 'blk'
    - If not, print appropriate error message (reason for the error)
  - Argument
    - blk : Address of the NAND flash memory
  - Return value
    - Return 0 on success
    - Return -1 on errors

nand_blkdump()

- nand_blkdump(*blk*)
  - Description
    - Dump the contents of the flash memory block 'blk' (for debug)
    - If success, print appropriate message with 'blk'
    - If not, print appropriate error message (reason for the error)
  - Argument
    - blk : Address of the NAND flash memory
  - Return value
    - Return 0 on success
    - Return -1 on errors

Sample Output

```
sally@dylee:~/nandsim$ ./nandsim
NAND: 8 blocks, 8 pages per block, 64 pages
write(3,0): data = 0x00000000, spare = 0x00000000
write(3,1): data = 0x00000001, spare = 0x00010000
write(3,2): data = 0x00000002, spare = 0x00020000
write(3,3): data = 0x00000003, spare = 0x00030000
write(3,4): data = 0x00000004, spare = 0x00040000
write(3,5): data = 0x00000005, spare = 0x00050000
write(3,6): data = 0x00000006, spare = 0x00060000
write(3,7): data = 0x00000007, spare = 0x00070000
read(3,7): data = 0x00000007, spare = 0x00070000
read(3,6): data = 0x00000006, spare = 0x00060000
read(3,5): data = 0x00000005, spare = 0x00050000
read(3,4): data = 0x00000004, spare = 0x00040000
read(3,3): data = 0x00000003, spare = 0x00030000
read(3,2): data = 0x00000002, spare = 0x00020000
read(3,1): data = 0x00000001, spare = 0x00010000
read(3,0): data = 0x00000000, spare = 0x00000000
write(4,0): data = 0x0000cafe, spare = 0x0000babe
write(4,0): failed, the page was already written
write(4,2): failed, the page is not being sequentially written
read(4,3): failed, trying to read an empty page
read(0,0): failed, trying to read an empty page
read(7,0): failed, trying to read an empty page
erase(3): block erased
erase(4): block erased
erase(0): failed, trying to erase a free block
write(3,0): data = 0x00000000, spare = 0x00000000
write(3,1): data = 0x01000000, spare = 0x00000001
write(3,2): data = 0x02000000, spare = 0x00000002
write(3,3): data = 0x03000000, spare = 0x00000003
write(3,4): data = 0x04000000, spare = 0x00000004
write(3,5): data = 0x05000000, spare = 0x00000005
write(3,6): data = 0x06000000, spare = 0x00000006
```

```
write(3,7): data = 0x07000000, spare = 0x00000007
write(4,0): data = 0x00000bad, spare = 0x00c0ffee
write(4,1): data = 0x0000face, spare = 0x0000b00c
read(3,0): data = 0x00000000, spare = 0x00000000
read(4,0): data = 0x00000bad, spare = 0x00c0ffee
write(4,-1): failed, invalid page number
read(4,-1): failed, invalid page number
write(4,8): failed, invalid page number
read(4,8): failed, invalid page number
write(-1,0): failed, invalid block number
read(-1,0): failed, invalid block number
write(8,0): failed, invalid block number
read(8,0): failed, invalid block number
erase(-1): failed, invalid block number
erase(8): failed, invalid block number
erase(1000008): failed, invalid block number
Blk     0: FREE
Blk     1: FREE
Blk     2: FREE
Blk     3: Total 8 page(s) written
    Page   0: data = 0x00000000, spare = 0x00000000
    Page   1: data = 0x01000000, spare = 0x00000001
    Page   2: data = 0x02000000, spare = 0x00000002
    Page   3: data = 0x03000000, spare = 0x00000003
    Page   4: data = 0x04000000, spare = 0x00000004
    Page   5: data = 0x05000000, spare = 0x00000005
    Page   6: data = 0x06000000, spare = 0x00000006
    Page   7: data = 0x07000000, spare = 0x00000007
Blk     4: Total 2 page(s) written
    Page   0: data = 0x00000bad, spare = 0x00c0ffee
    Page   1: data = 0x0000face, spare = 0x0000b00c
Blk     5: FREE
Blk     6: FREE
Blk     7: FREE
```

Miscellaneous

- Recommended environment : Linux (Ubuntu is ok!)
  - You can do it in Windows, but be sure that your work also runs in Linux (I'll score all the works only in Linux)
- Personal Project
- Submit to the e-mail (minwoo.ahn@csl.skku.edu)
  - Your submission status will be noticed in course homepage
- Late penalty : -20 % / day

Any Questions?