Reliability Issues/Test

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Contents

- ECC check
- Power-Off Recovery
- Bad Block
- FTL Test

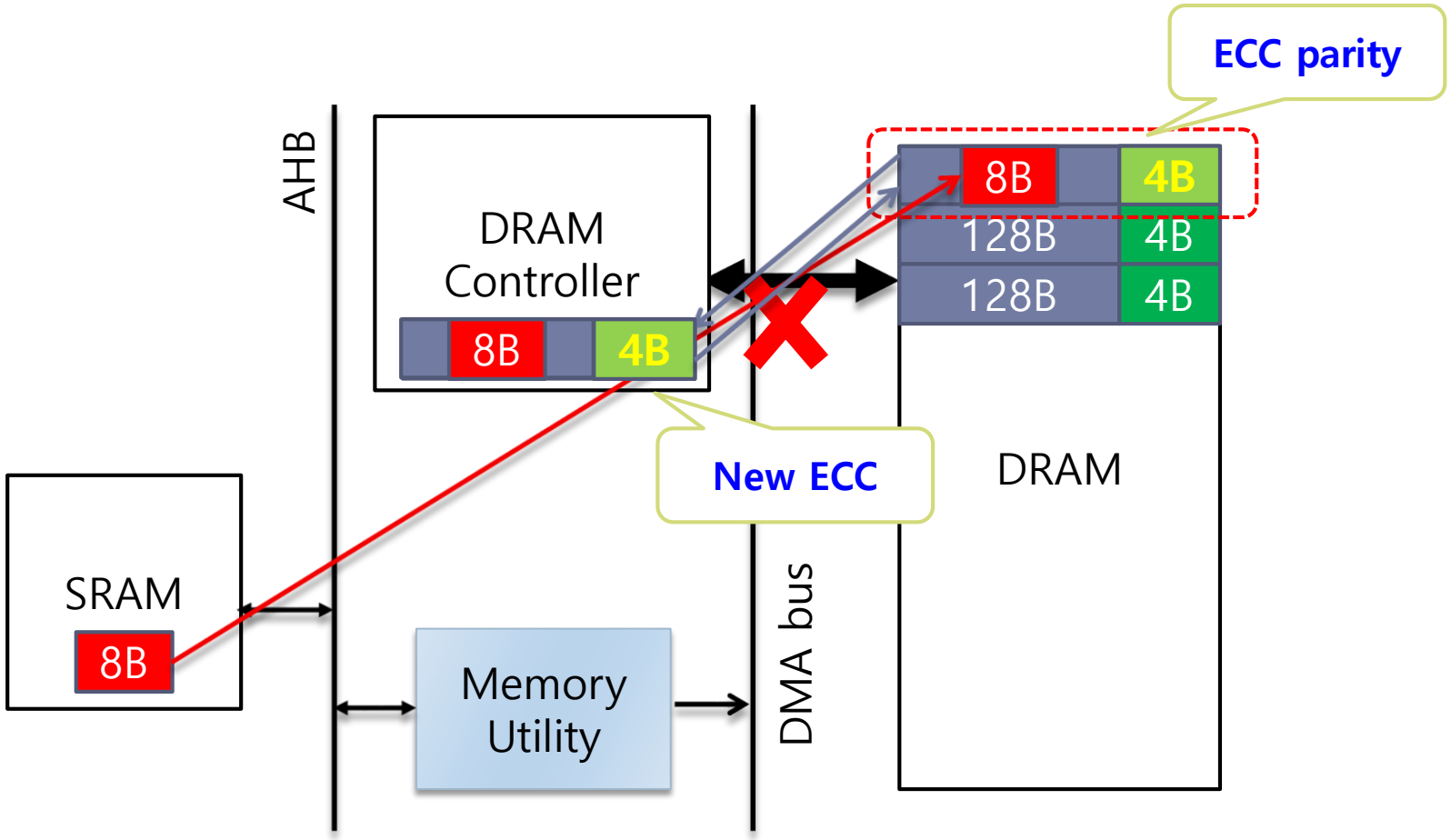
DRAM Controller

- DRAM ECC
  - Check and correct DRAM bit errors
  - 128 Byte + 4 Byte ECC Parity

- Memory Utility
  - Support data transmission from/to DRAM
    - SRAM to DRAM, DRAM to SRAM, DRAM to DRAM
  - ./include/mem_util.h

DRAM Controller

- Write 8 Byte data from SRAM to DRAM



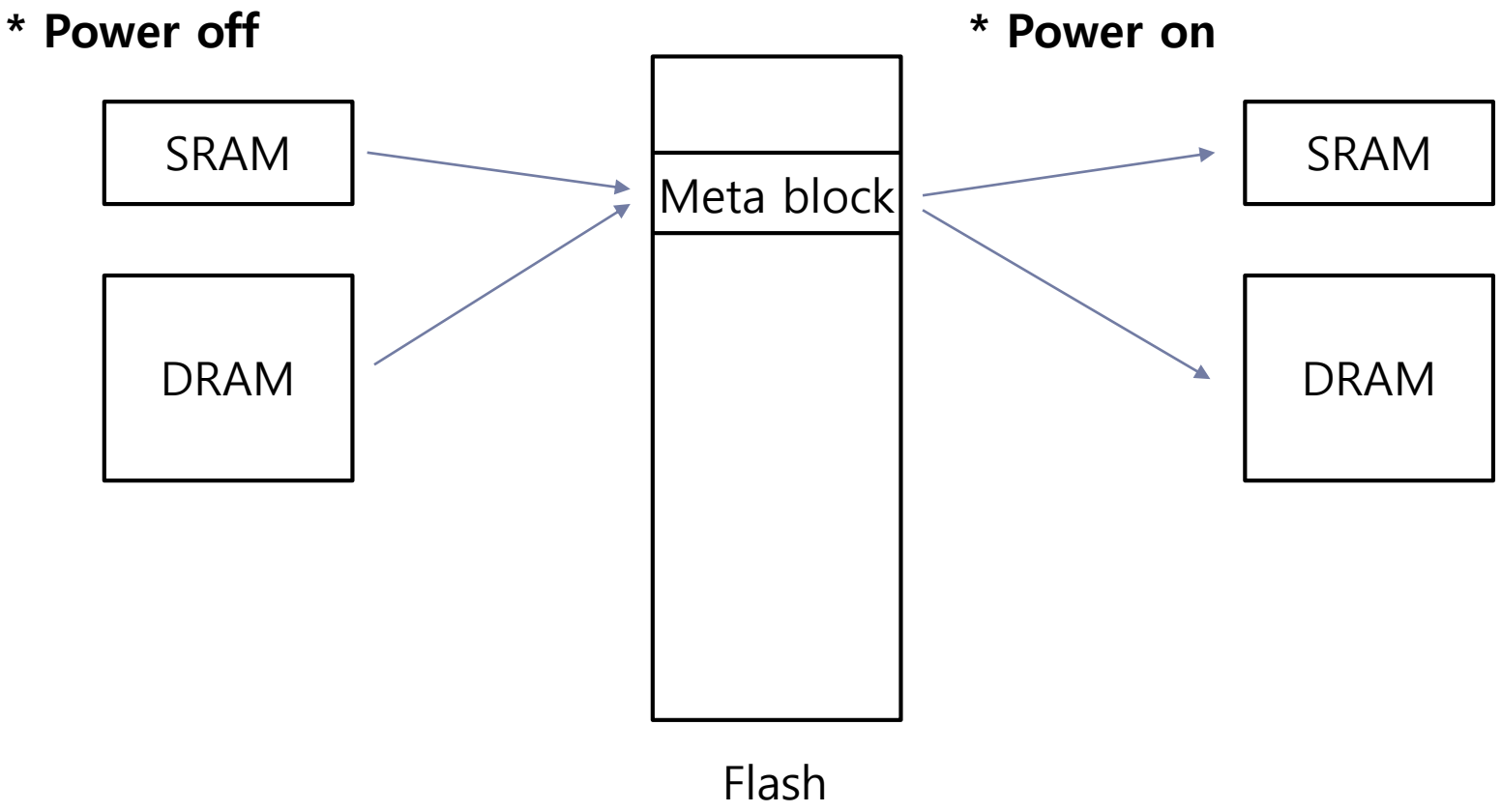
Power-Off Recovery

- Power-off leads the data loss
  - Userdata that resides in write buffer
  - Metadata that resides in SRAM and DRAM
    - Page-level mapping table

- Recover mapping table on next power-on
  - On program operation, store LPN into spare area
  - By scanning spare area, mapping table can be reconstructed

Power-Off Recovery

- Store and recover metadata



Bad Block

- Bad block cannot be used
  - Data in bad block is crashed
  - Any operation cannot be operated

Bad Block

- Initial bad block
  - Bad block caused by problem in manufacturing process
- Runtime bad block
  - Bad block caused by wearing out

Bad Block

- Bad block detecting
  - Initial bad block
    - Scan block #0
  - Runtime bad block
    - Invoke interrupt service
- Bad block handling
  - Avoid using bad block
  - Remapping to reserved block

Bad Block

- ftl_isr()

```
// BSP interrupt service routine
void ftl_isr(void)
{
    UINT32 bank;
    UINT32 bsp_intr_flag;

    uart_print("BSP interrupt occured...");
    // interrupt pending clear (ICU)
    SETREG(APB_INT_STS, INTR_FLASH);

    for (bank = 0; bank < NUM_BANKS; bank++) {
        while (BSP_FSM(bank) != BANK_IDLE);
        // get interrupt flag from BSP
        bsp_intr_flag = BSP_INTR(bank);

        if (bsp_intr_flag == 0) {
            continue;
        }
        UINT32 fc = GETREG(BSP_CMD(bank));
        // BSP clear
        CLR_BSP_INTR(bank, bsp_intr_flag);

        // interrupt handling
        if (bsp_intr_flag & FIRQ_DATA_CORRUPT) {
            uart_printf("BSP interrupt at bank: 0x%x", bank);
            uart_print("FIRQ_DATA_CORRUPT occured...");
        }
        if (bsp_intr_flag & (FIRQ_BADBLK_H | FIRQ_BADBLK_L)) {
            uart_printf("BSP interrupt at bank: 0x%x", bank);
            if (fc == FC_COL_ROW_IN_PROG || fc == FC_IN_PROG || fc == FC_PROG) {
                uart_print("find runtime bad block when block program...");
            }
            else {
                uart_printf("find runtime bad block when block erase...vblock #: %d", GETREG(BSP_ROW_H(bank)) / PAGES_PER_BLK);
                ASSERT(fc == FC_ERASE);
            }
        }
    }
}
```

FTL test

- In the host PC
  - Send read/write command to jasmine board.
- In the Firmware(Next Week)
  - Use ftl_test()
- Real task
  - File Copy and Read
  - Kernel Compile
  - Compression
  - Sort

FTL test

```
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>
#include<unistd.h>

int main(){
    int fd = open("/dev/sdb",O_RDWR|O_SYNC);
    int i;

    if(fd == -1) return 0;

    char ch[256]={"I am Sejun Kwon, Computer Systems Laboratory"};
    char ch_out[256];

    lseek(fd, 10, SEEK_SET);
    write(fd, ch, 10);
    lseek(fd, 13, SEEK_SET);
    read(fd, ch_out, 9);
    for(i=0;i<9;i++)
        putchar(ch_out[i]);
    return 0;
}
```

FTL test

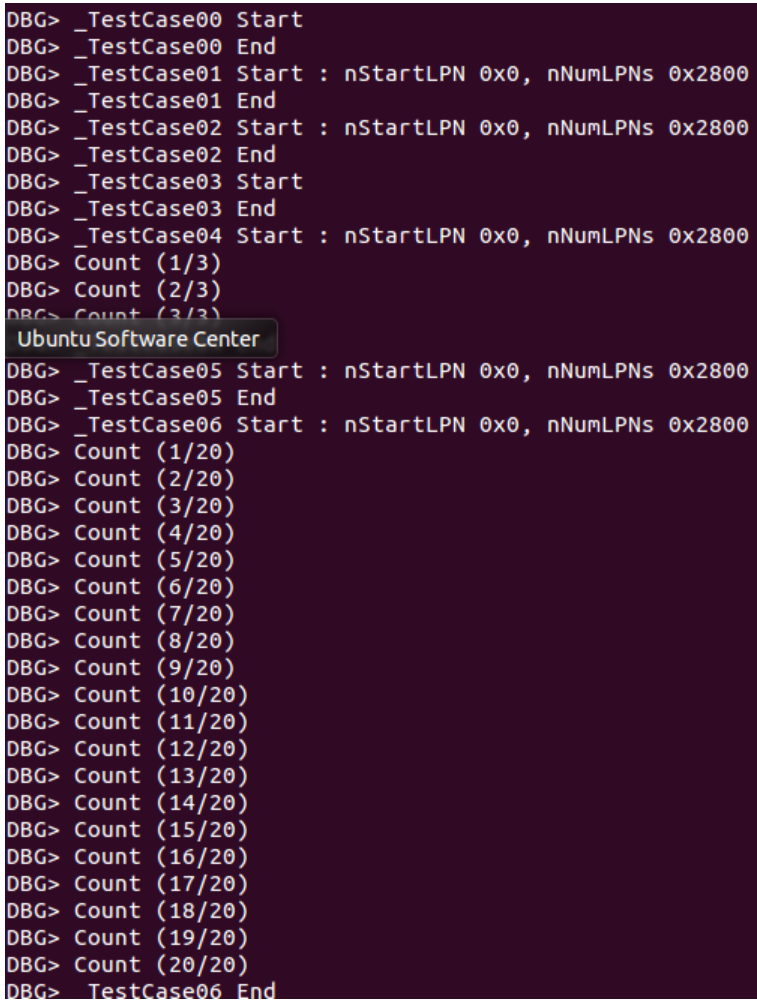
```
root@ubuntu:/home/sejun000/jasmine# ./a.out
m Sejunroot@ubuntu:/home/sejun000/jasmine#
```

- We can open device as file.
  - Confirm device name with “fdisk –l”
- We can select LBA(logical block address) with lseek.

FTL test

- In-Firmware Test
  - Not communicate SATA
  - DRAM <-> NAND
  - In jasmine.h

- #define OPTION_FTL_TEST 1
- #define OPTION_UART_DEBUG 1



FTL test

- Kernel Compile
  - Get from www.kernel.org
  - make menuconfig
  - make –j2

- Compression
  - Random Read/Sequential Write
  - Data Compare
  - Zlib, LZO, LZ4

FTL test

- Sort
  - Quick Sort
    - Swap -> In place update
    - Occur Random Read/Write
  - Merge Sort
    - Sequential Read, Sequential Write

Any Questions?