SSD Firmware Implementation Project
- Lab. #8-

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Lab. Time Schedule

Lab.	Title
#1	FTL Simulator Development Guide
#2	FTL Simulation Guide
#3	Project 1 Presentation
#4	Jasmine OpenSSD platform tutorial #1
#5	Jasmine OpenSSD platform tutorial #2
#6	FTL Porting Guide
#7	Firmware Debugging Guide
#8	**SSD Performance Evaluation Guide**
#9	Project 2 Presentation

FTL Evaluation Guide

1. Before benchmarking, you have to verify the FTL logics first
2. Microscopic analysis with measuring the response time & Code optimization
   - Processing overhead
   - Garbage collection overhead
3. Performance test with commercial/well-known storage benchmark tools

FTL Logic Test Guide

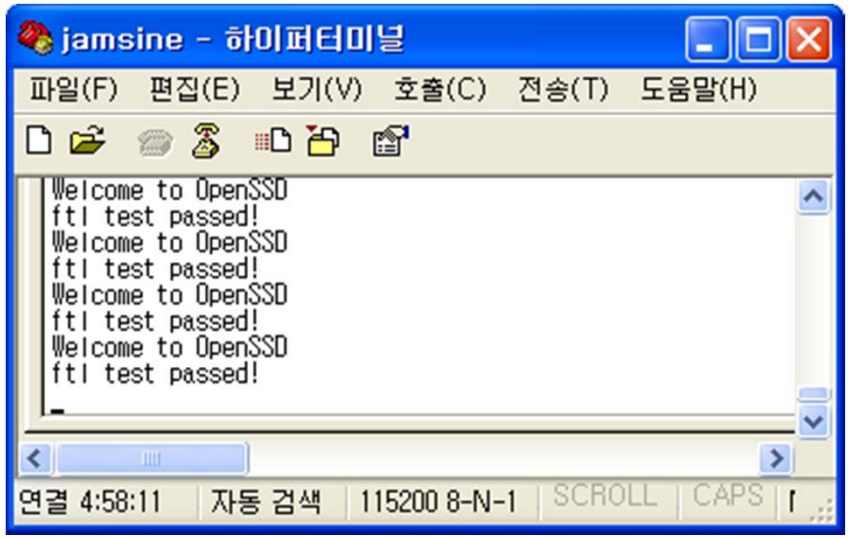
```
void ftl_test(void)
{
    ...
    io_cnt = 500;
    num_sectors = 4;
    ...

    // STEP 1 - write
    for (i = 0; i < io_cnt; i++){
        wr_buf_addr = WR_BUF_PTR(g_ftl_write_buf_id) +
                      ((lba % SECTORS_PER_PAGE) * BYTES_PER_SECTOR);
        for (j = 0; j < num_sectors; j++){
            mem_set_dram(wr_buf_addr, data, BYTES_PER_SECTOR);

            wr_buf_addr += BYTES_PER_SECTOR;

            if (wr_buf_addr >= WR_BUF_ADDR + WR_BUF_BYTES) {
                wr_buf_addr = WR_BUF_ADDR;
            }
            data++;
        }
        ftl_write(lba, num_sectors);
        lba += num_sectors;
    }
    ...
```

FTL Logic Test Guide (contd.)

```
    // STEP 2 - read and verify
    for (i = 0; i < io_cnt; i++)
    {
        rd_buf_addr = RD_BUF_PTR(g_ftl_read_buf_id) +
                      ((lba % SECTORS_PER_PAGE) * BYTES_PER_SECTOR);
        ftl_read(lba, num_sectors);

        flash_finish();

        for (j = 0; j < num_sectors; j++) {
            UINT32 sample = read_dram_32(rd_buf_addr);

            if (sample != data) {
                uart_print("ftl test fail...");
                led_blink();
            }
            rd_buf_addr += BYTES_PER_SECTOR;

            if (rd_buf_addr >= RD_BUF_ADDR + RD_BUF_BYTES) {
                rd_buf_addr = RD_BUF_ADDR;
            }
            data++;
        }
        lba += num_sectors;
    }
    ...
}
```

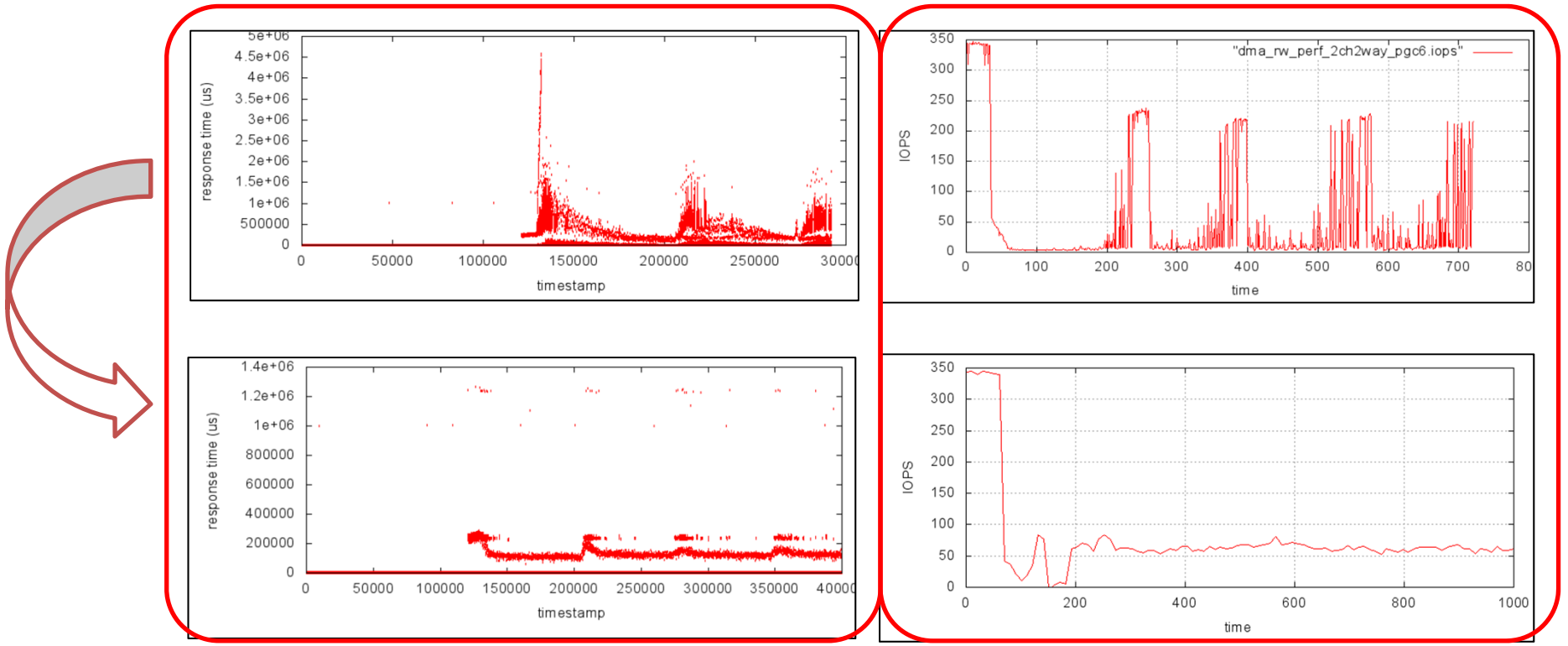
FTL Logic Test Guide (contd.)

- POR(Power-Off Recovery) Test
  - Enable **`OPTION_FTL_TEST`** in **`jasmine.h`**
  - Toggle Power-On/Off Switch after finishing **`ftl_test()`**



FTL Logic Optimization

- Performance fluctuation normalization
  - IO Response time & Throughput



Performance Evaluation: Introduction

- SSD Benchmarking
  - PCMark05
  - Iometer benchmark tool
- c.f.) IO bandwidth limitation
  - In current Jasmine version, only two channels enabled (2CH/4WAY)
    - BANK_BMP(A0,B0, A1,B1, A4,B4, A5,B5)
  - Raw device
    - 256KB Sequential read: < 100MB/s
    - 256KB Sequential write: < 85~90MB/s

Performance Evaluation: Introduction

1. Install new firmware
   - Enable **`OPTION_REDUCED_CAPACITY`** in **`jasmine.h`**
   - Reduce SSD Storage size 64GB to 8GB
2. Format Jasmine (erase all blocks)
3. **w/ Iometer**
   - To evaluate firmware perf. before/after GC
   - Raw device test
4. **w/ PCMark05**
   - To evaluate overall test under the file system
   - Windows XP startup, Application loading, Virus scan, File write, etc.

Performance Evaluation: Iometer

- **Iometer**
  1. 256KB Sequential write (30sec)
  2. 256KB Sequential read (30sec)
  3. 8KB Random write (30sec)
  4. 8KB Random read (30sec)
  5. Aging (8KB Random write) (30min~)
  6. 8KB Random write (1min)
  7. 8KB Random read (30sec)
  8. 256KB Sequential write (1min)
  9. 256KB Sequential read (30sec)

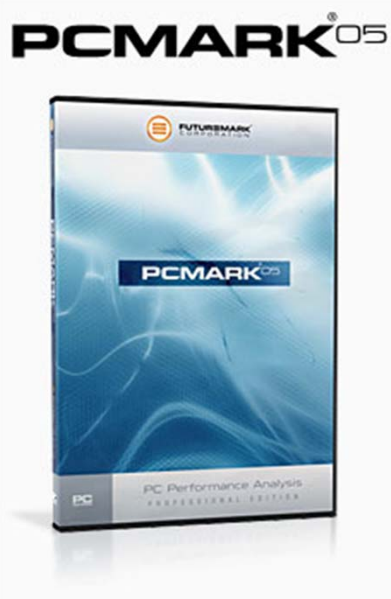
- **Sequential -> MB/s**
- **Random -> IOPS**

Before GC

After GC

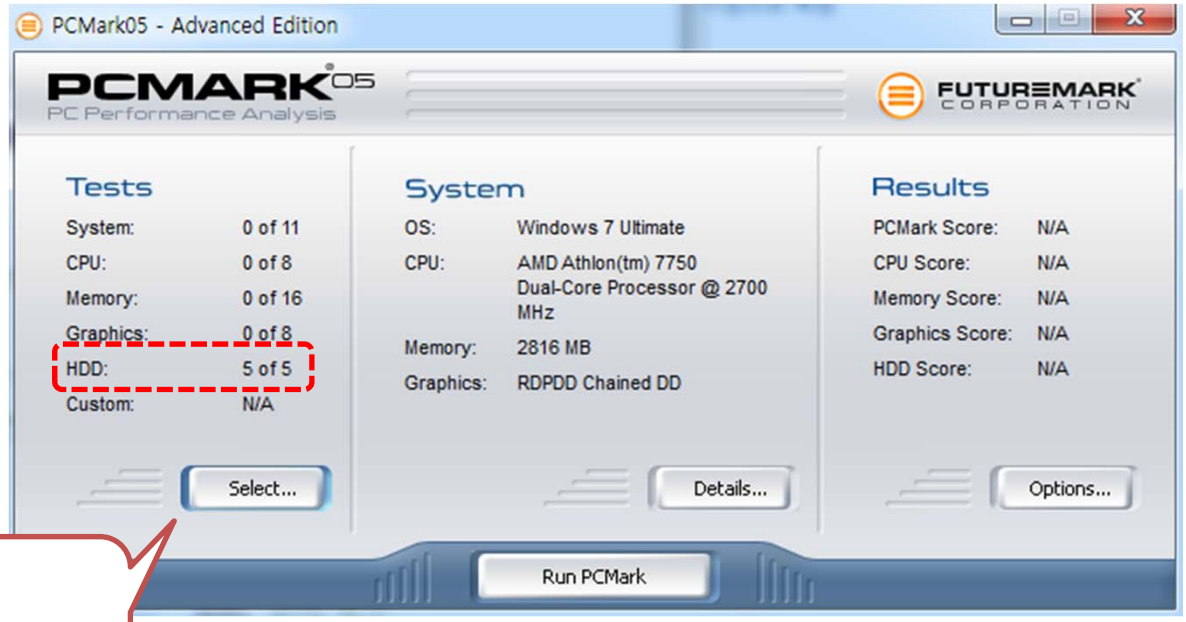
Performance Evaluation: PCMark05

- **PCMark05**
  - Download a basic edition (v.1.2.0)
    http://www.futuremark.com/download/pcmark05/



Performance Evaluation: PCMark05

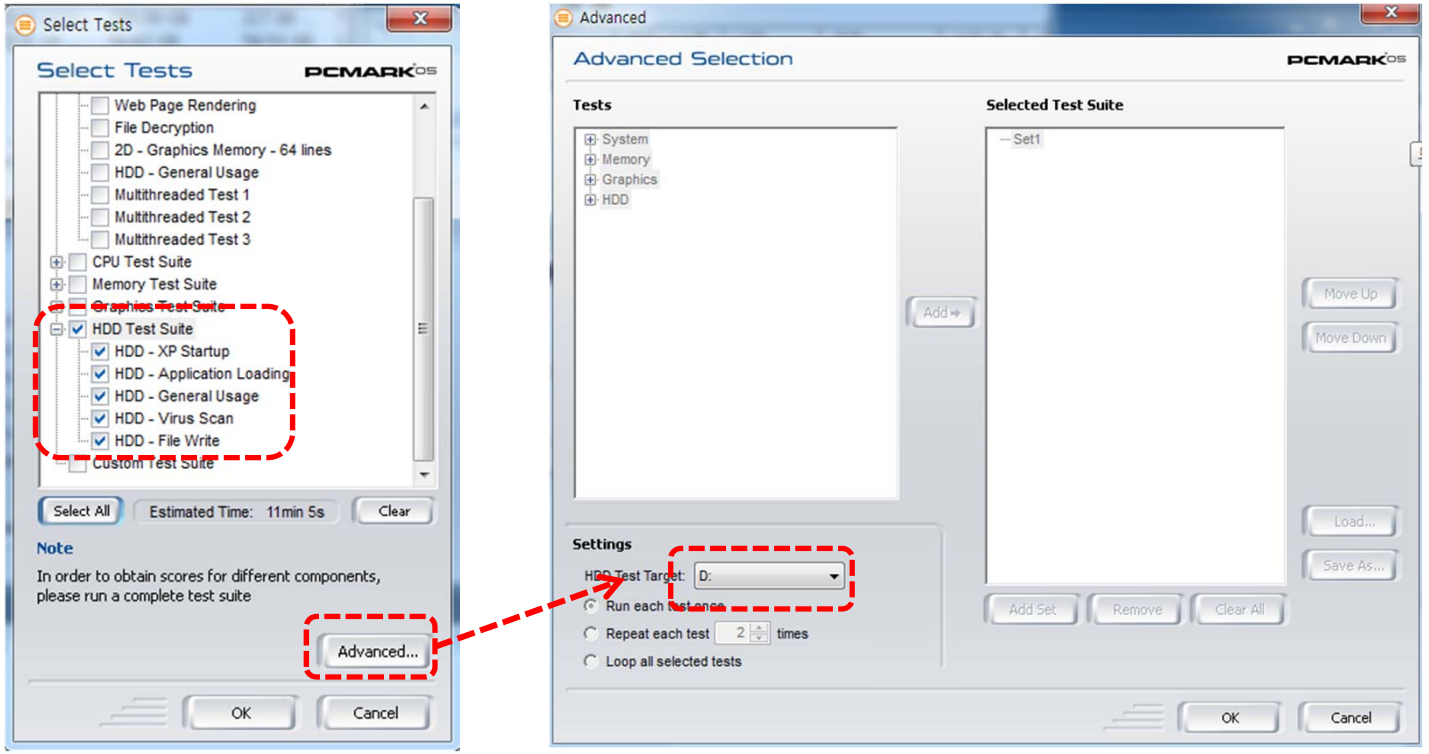
- Run PCMark05



Test configuration

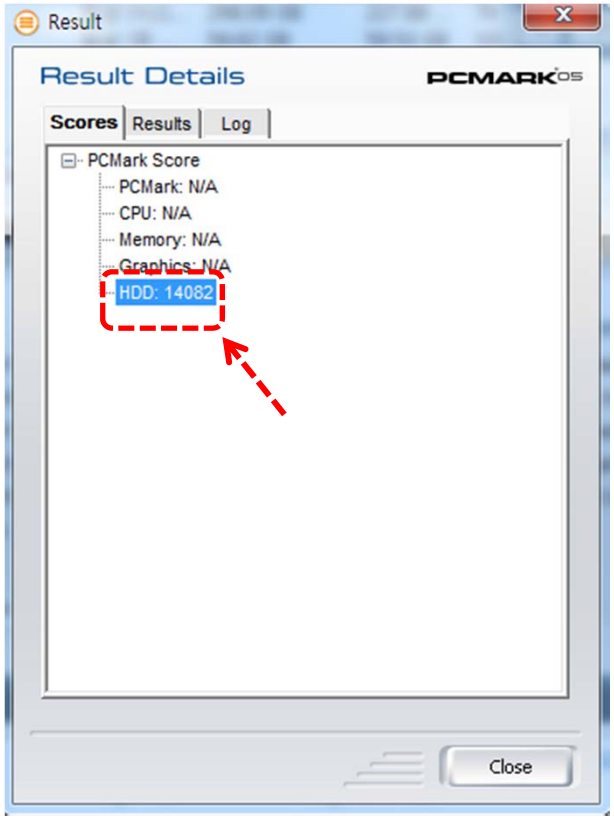
Performance Evaluation: PCMark05

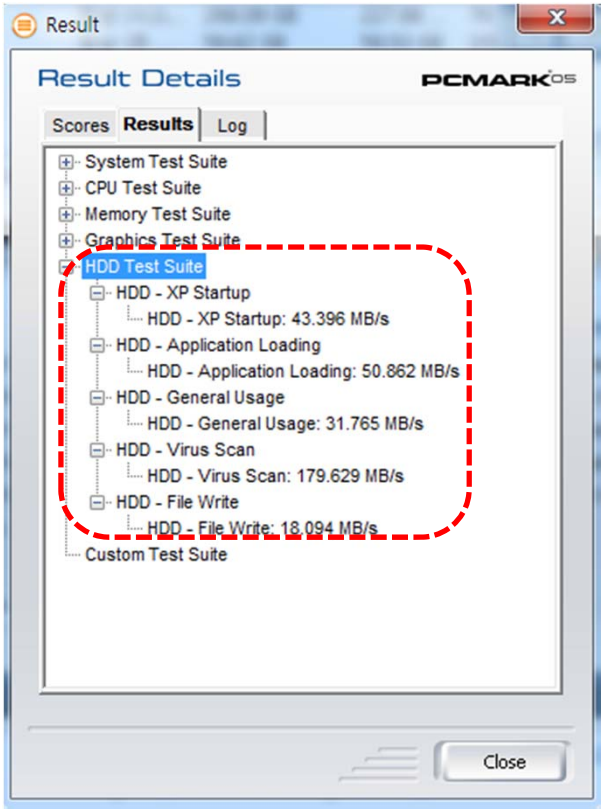
- Test configuration (HDD Test Suite)



Performance Evaluation

- Benchmarking & See benchmark score





Evaluation Result

- Summarize your evaluation results
  - w/ Iometer
  - w/ PCMark05
- Plotting results
  - Bar/Graph, etc.

Any Questions?