2024 FTL Study Experiment & Topics

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File System Experiment

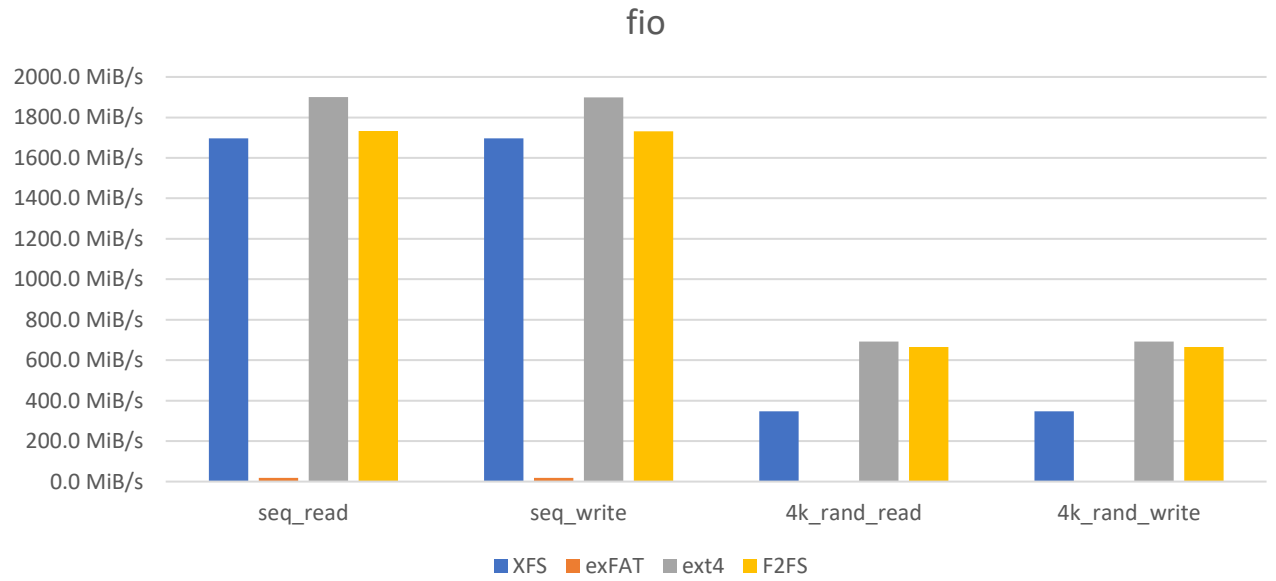
- Vary file system to evaluate throughput in FEMU

- Settings:
  - In FEMU
  - Host system environment: CPU: i7-6700 | RAM: DDR4 8GB * 2, 2133MT/s
  - /proc/sys/vm/vfs_cache_pressure = 100 (default settings, not direct IO)

- Target file system:
  - XFS, exFAT, ext4, F2FS

FIO_256MiB

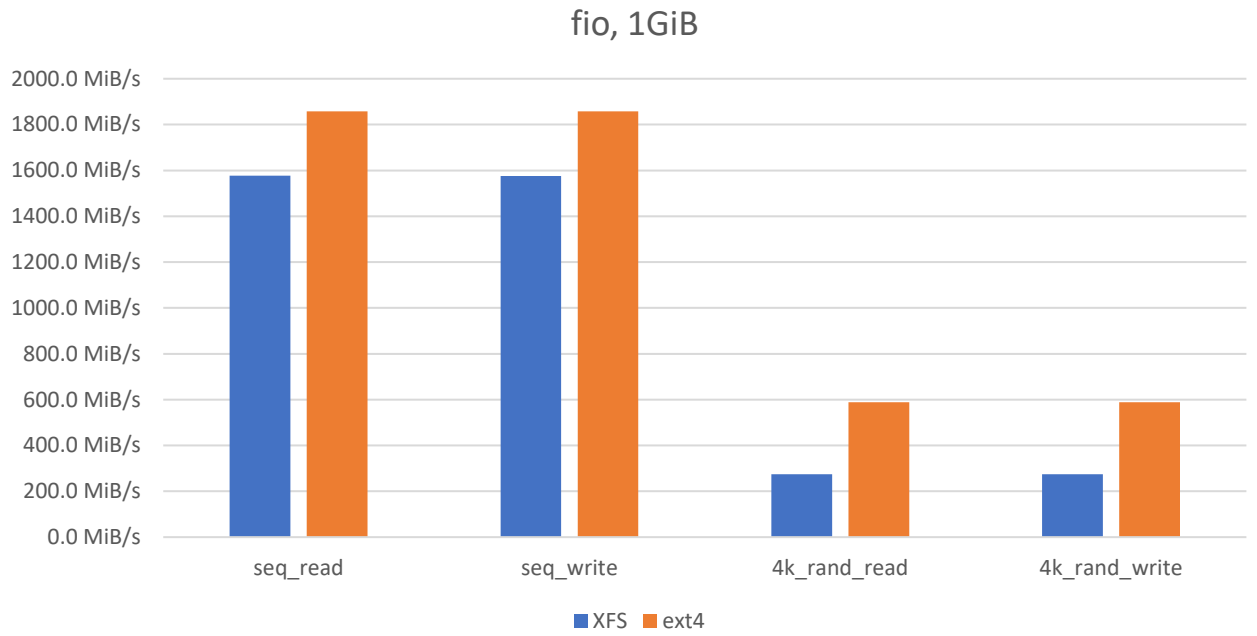
- fio_seq = sudo fio --name=seq_rw --filename=./testfile --rw=rw --bs=4K --size=256M --numjobs=4 --runtime=30 --time_based --group_reporting
- fio_rand = sudo fio --name=rw --filename=./testfile --rw=randrw --bs=4k --size=256M --numjobs=4 --runtime=30 --time_based --group_reporting



- *We also increased the buffer size used to 32KiB and define numjobs to 4 to fork 4 identical jobs. The result is 4 processes each randomly writing to their own 64MiB file.* (from fio doc.)
  - 하나의 파일이 아닌 각 job이 각각 파일을 1개씩 만듦
- XFS가 느린 이유? -> XFS가 큰 파일에 유리? -> 1GiB로 실험 확인 (다음 장)

FIO_1GiB

- fio_seq = sudo fio --name=seq_rw --filename=./testfile --rw=rw --bs=4K --size=1G --numjobs=4 --runtime=30 --time_based --group_reporting
- fio_rand = sudo fio --name=rw --filename=./testfile --rw=randrw --bs=4k --size=1G --numjobs=4 --runtime=30 --time_based --group_reporting



- XFS가 더 빠르지 않음, 다른 이유를 찾거나 1GiB보다 더 크게 실험
  - FEMU가 메모리 한계가 있으므로, host 시스템에서 실험?

관심 분야

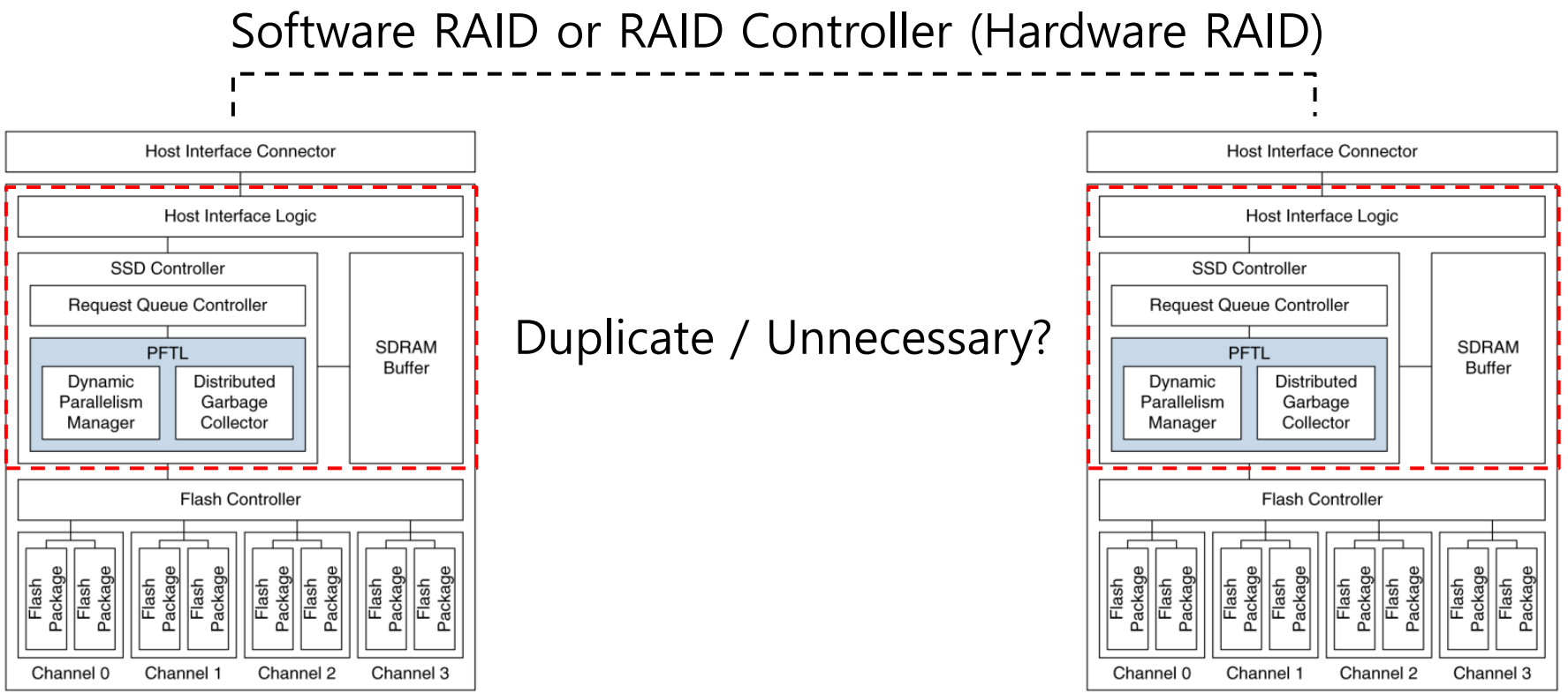
1. **SSD에서 RAID 1(Mirroring)을 구성할 때 중복되는 Controller 제거 가능성 연구**

2. LearnedFTL, LeaFTL에서의 하드웨어 사용량 분석 (DRAM usage, CPU utilization)

3. DRAM-less SSD의 구성과 한계 및 극복 방법 (NVMe의 Host Memory Buffer 등)

RAID 1에서 중복되는 Controller 제거

Motivation

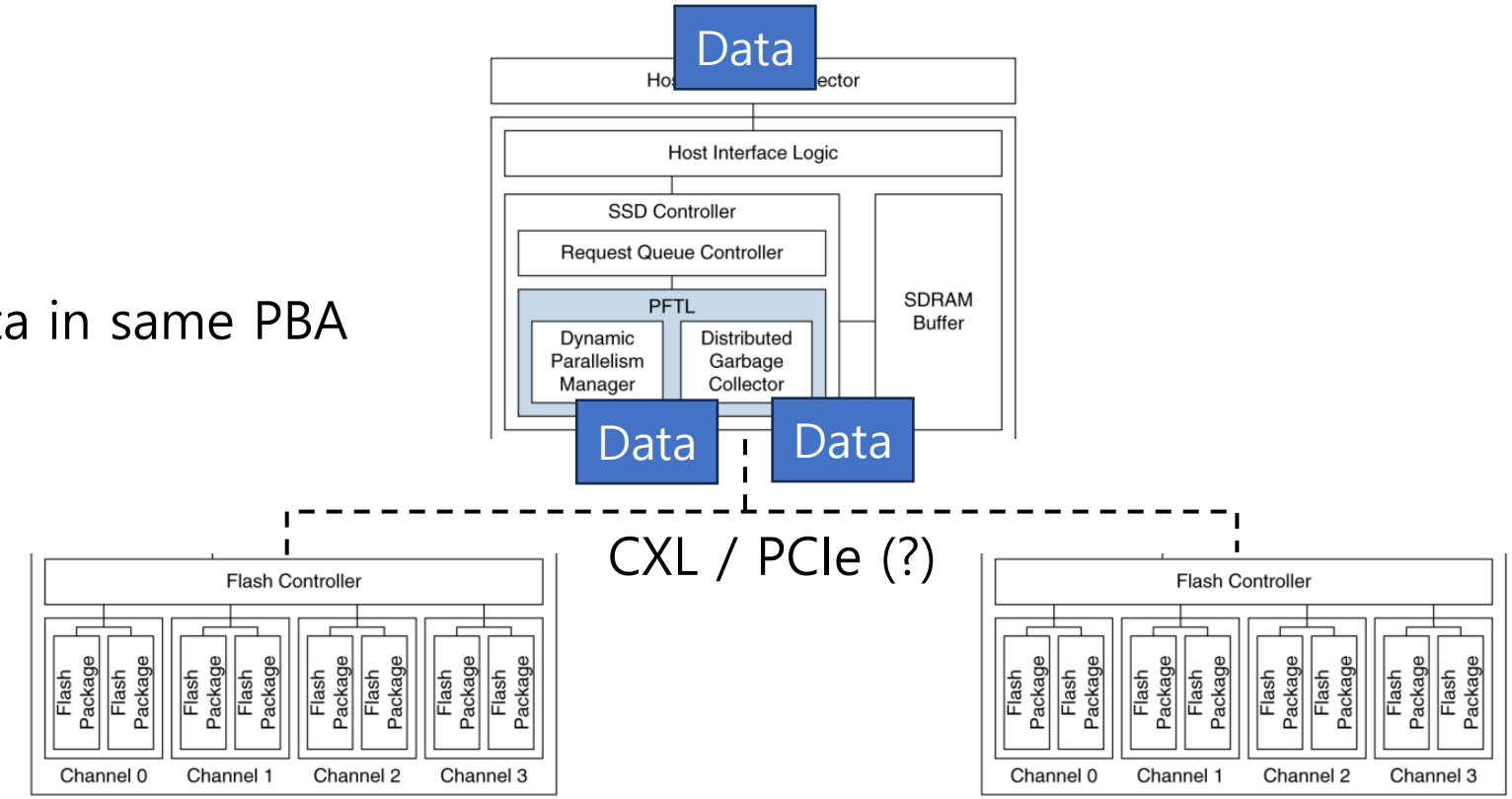


Ref: Hsieh, Jen-Wei, Han-Yi Lin, and Dong-Lin Yang. "Multi-channel architecture-based FTL for reliable and high-performance SSD." IEEE Transactions on Computers 63.12 (2013): 3079-3091.

RAID 1에서 중복되는 Controller 제거

Target RAID system

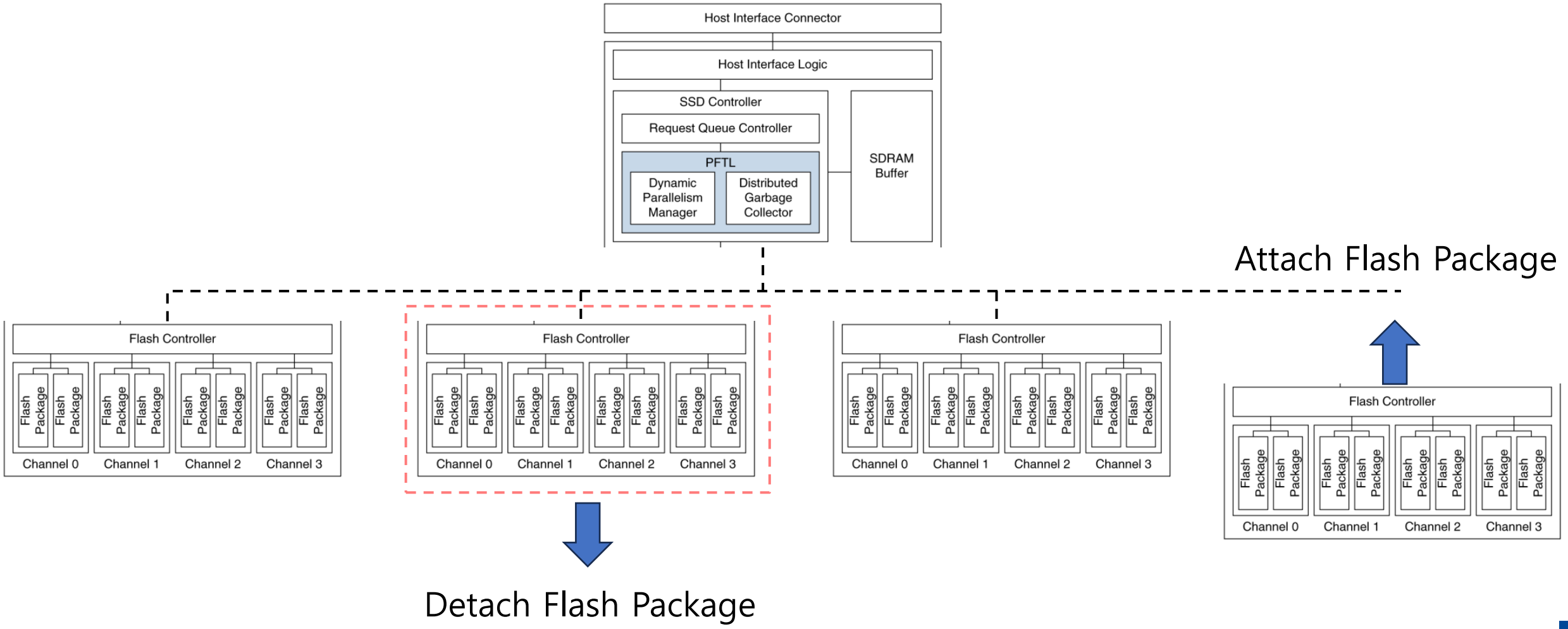
Store same data in same PBA



(Physically Separated Flash Packages)

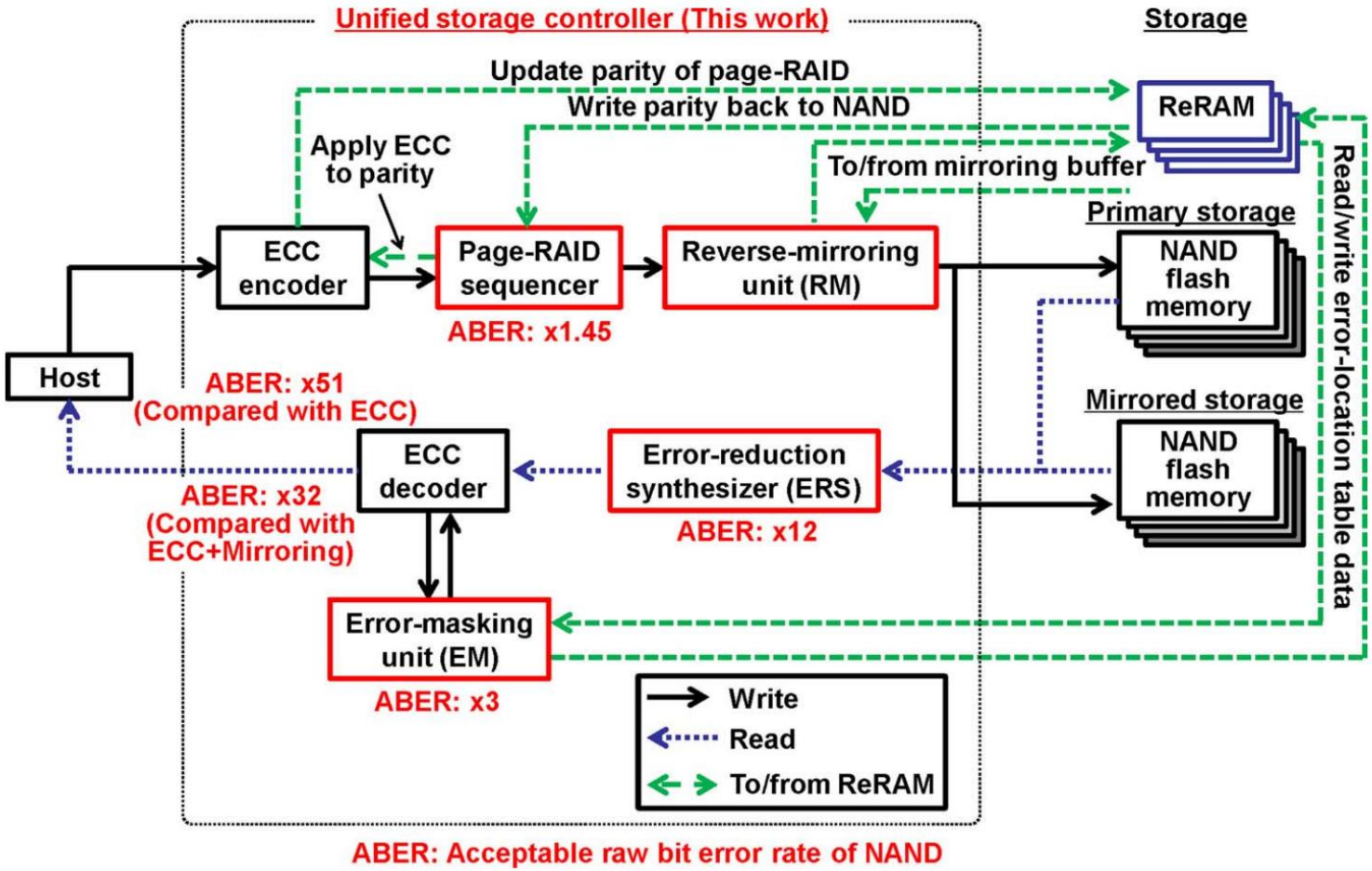
RAID 1에서 중복되는 Controller 제거

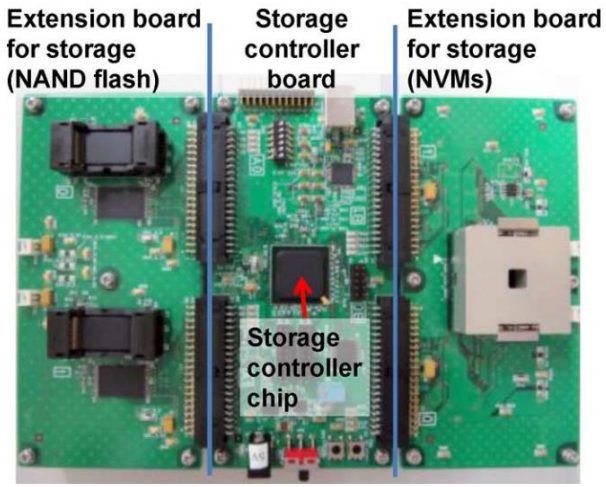
Ultimate Goal: Flexibly Attach-Detach Flash Package



관련 연구

- Unified Solid-State Storage (USSS)
- Tanakamaru, Shuhei, Masafumi Doi, and Ken Takeuchi. "NAND flash memory/ReRAM hybrid unified solid-state-storage architecture." *IEEE Transactions on Circuits and Systems I: Regular Papers* 61.4 (2013): 1119-1132.





RAID 1에서 중복되는 Controller 제거

TODO:

- Make test environment in FEMU
  - Separate flash package and controller

Consideration:

- Does discarding duplicate controllers worth it?
  - Have practical merit?

- Controller location
  - Host or separate device?

- Flash package location
  - Connect to controller (pass through Controller)
  - Connect directly to motherboard (Southbridge)