基於 gem5 架構之 SSD 彈性資料放置模擬器

A Simulator for Flexible Data Placement in SSDs Based on gem5

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開發工具：GCC、VS code
測試環境：Linux ubuntu24.04

一、簡介：

To address the limitations of traditional SSDs—such as write amplification, low space utilization, and the serious overhead associated with garbage collection (GC) and wear leveling (WL)—Flexible data placement (FDP) is proposed. FDP introduces a finer-grained and more adaptable data placement strategy, enabling data to be written directly to arbitrary locations in NAND flash memory, including sub-page and cross-page boundaries, thereby eliminating the constraints of page- or block-aligned writes. However, existing simulators support only conventional SSD architectures. To bridge this gap, this work presents an open-source FDP-enabled simulator built on the gem5 framework, facilitating future research in this area.

二、測試結果：

```
smallwhitela@LAPTOP-DB1K2D0O:~/gg2/gem5$ ./build/X86/gem5.opt configs/deprecated/example/se.py  --mem-type=FDPMemory --cpu-type=TimingSimpleCPU -c memtest
gem5 Simulator System.  https://www.gem5.org
gem5 is copyrighted software; use the --copyright option for details.

gem5 version 24.1.0.2
gem5 compiled May 27 2025 15:29:32
gem5 started May 27 2025 15:41:40
gem5 executing on LAPTOP-DB1K2D0O, pid 6158
command line: ./build/X86/gem5.opt configs/deprecated/example/se.py --mem-type=FDPMemory --cpu-type=TimingSimpleCPU -c memtest

warn: The se.py script is deprecated. It will be removed in future releases of  gem5.
Global frequency set at 1000000000000 ticks per second
src/base/statistics.hh:279: warn: One of the stats is a legacy stat. Legacy stat is a stat that does not belong to any statistics::Group. Legacy stat is deprecated.
[FDPMemory] Initialized!
src/base/statistics.hh:279: warn: One of the stats is a legacy stat. Legacy stat is a stat that does not belong to any statistics::Group. Legacy stat is deprecated.
system.remote_gdb: Listening for connections on port 7000
**** REAL SIMULATION ****
src/sim/simulate.cc:199: info: Entering event queue @ 0.  Starting simulation...
src/sim/syscall_emul.cc:86: warn: ignoring syscall set_robust_list(...)
src/sim/syscall_emul.cc:86: warn: ignoring syscall rseq(...)
src/sim/mem_state.cc:448: info: Increasing stack size by one page.
src/sim/syscall_emul.cc:86: warn: ignoring syscall mprotect(...)
Sum: 499500
Exiting @ tick 2254985000 because exiting with last active thread context
smallwhitela@LAPTOP-DB1K2D0O:~/gg2/gem5$
```

```
s.placement_access_count::0        29688                       # Number of accesses per placement ID (Unspecified)
s.placement_access_count::1         1329                       # Number of accesses per placement ID (Unspecified)
s.placement_access_count::2         2309                       # Number of accesses per placement ID (Unspecified)
s.placement_access_count::3         1324                       # Number of accesses per placement ID (Unspecified)
s.placement_access_count::4         1479                       # Number of accesses per placement ID (Unspecified)
s.placement_access_count::5         1735                       # Number of accesses per placement ID (Unspecified)
s.placement_access_count::6           50                       # Number of accesses per placement ID (Unspecified)
s.placement_access_count::7         1122                       # Number of accesses per placement ID (Unspecified)
s.placement_access_count::8           12                       # Number of accesses per placement ID (Unspecified)
s.placement_access_count::9            2                       # Number of accesses per placement ID (Unspecified)
s.placement_access_count::10        1362                        # Number of accesses per placement ID (Unspecified)
s.placement_access_count::11       15808                        # Number of accesses per placement ID (Unspecified)
s.placement_access_count::12           0                        # Number of accesses per placement ID (Unspecified)
s.placement_access_count::13           0                        # Number of accesses per placement ID (Unspecified)
s.placement_access_count::14           0                        # Number of accesses per placement ID (Unspecified)
s.placement_access_count::15           0                        # Number of accesses per placement ID (Unspecified)
```