



SLC & MLC Hybrid



SiliconMotion

Nelson Duann
Product Marketing Manager
Silicon Motion, Inc.

Tel: +886-2-2219-6688
nelson.duann@siliconmotion.com.tw
3F, No. 96, Mingcyuan Rd., Sindian
City, Taipei, Taiwan

Santa Clara, CA USA
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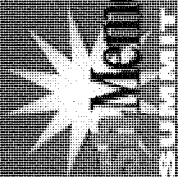


Agenda

- **SSD Today & Challenges**
 - The Hybrid SLC + MLC concept
- The Hybrid Technology
- About Silicon Motion

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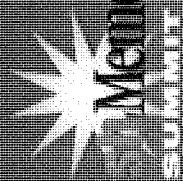


Flash Memory SSD today & Challenges

- Why SSD have not taken off → #1 price..
 - 95% of SSD products today used SLC NAND components
 - SLC price is about 3X MLC with the same density
 - 90%+ of NAND output from flash makers is MLC NAND
 - SSD won't become mainstream applications without using MLC NAND
- What are the technical concerns to use MLC for SSD applications?
 - Performance – longer programming time
 - Endurance – low program/erase cycles

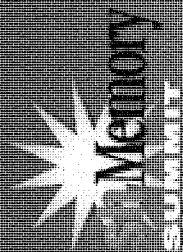
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- MLC is slow in host write CMD, especially for ran. write
 - NAND flash requires “erase” before writing data to old blocks.
 - MLC need 2 ms to 3 ms, and SLC need 1.5 ms to erase a block
 - MLC need average 800 us to program a page (strong page 200 to 400 us, weak page 1.2 to 1.5ms). SLC only need 200 us.
- How to improve MLC SSD performance?
 - NAND flash components might not be able to improve very much
 - Controller’s architecture in cache management and flash memory control



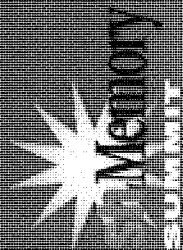
Endurance Concern

- MLC has limited endurance
 - The program and erase cycle of each MLC block is limited
 - MLC is around 5K to 10K cycles, SLC is 100k cycles
- How to improve endurance of SSD with MLC NAND?
 - Better wear-leveling algorithm -> Treat all NAND components as one memory unit (global wear-leveling)
 - Overcome data swapping endurance concern by storing the frequently updated data in the reliable area.



Suggested controller architectures

- Add caching mechanism
 - Bigger internal SRAM as cache
 - Utilize DRAM as cache
- Use both SLC and MLC (hybrid mode)



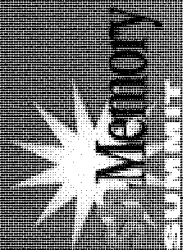
The Hybrid SLC+MLC Concept

	Pure SLC Based Flash	Pure MLC Based Flash
Performance	Fast access speed (2 times > MLC) Good!	Slow access speed
Durability	Good endurance (10~20 times > MLC) Good!	Poor endurance (5K-10K program/erase)
Cost	Expensive (2-3 times > MLC)	Cheaper Good!

Why not combine SLC & MLC chips in SSD?

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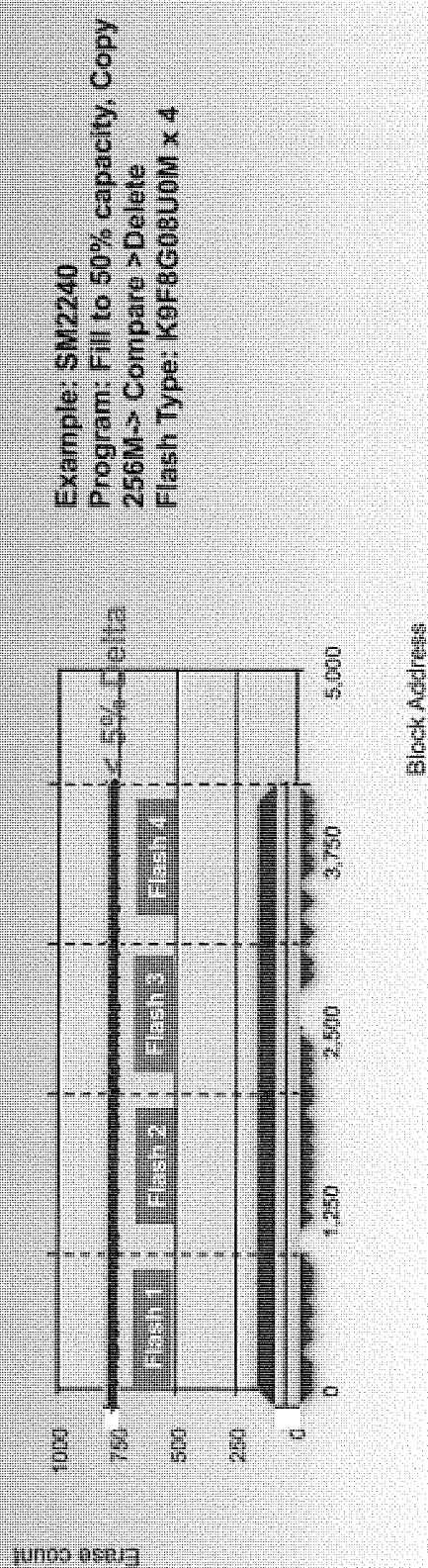
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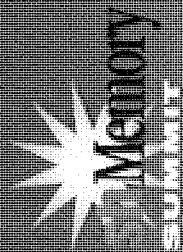
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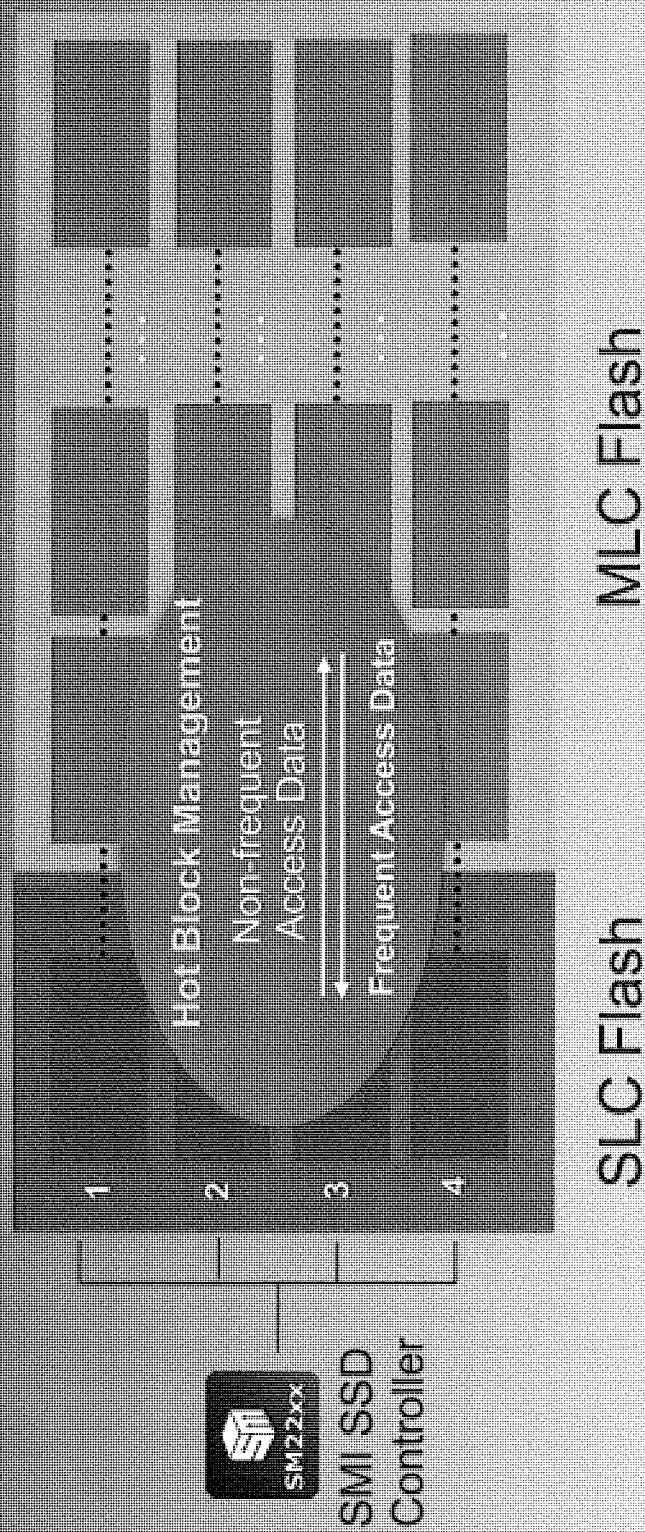
SMI Global Wear Leveling would even the erase count of all blocks, effectively wear level the entire SSD to extend the life expectancy..

- Manage all NAND flash components as one unified flash memory.
- Map host device's logical addresses into NAND flash physical addresses equally and randomly.
- Endurance will be further improved when the total density increases.





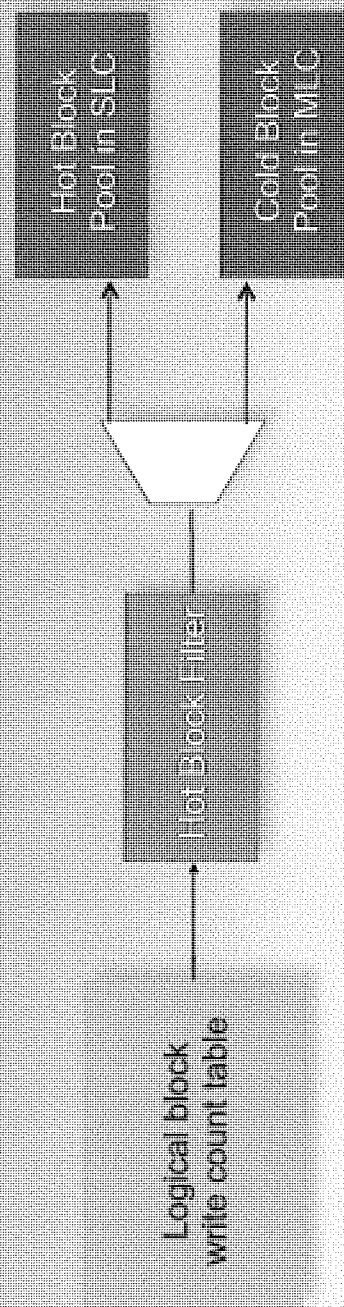
SMI SLC + MLC Hybrid Technology

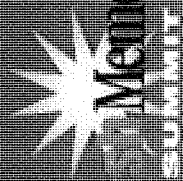


MLC cost with SLC performance and endurance!

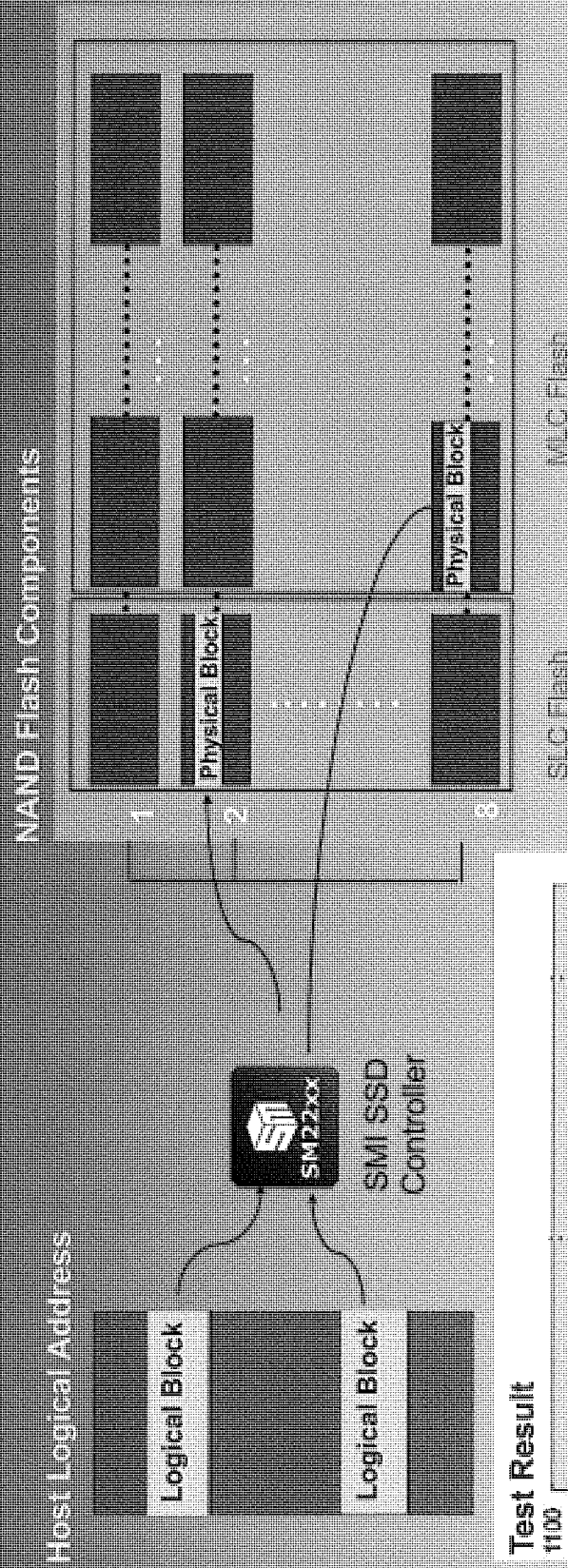
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- SMP's proprietary "Hot Block Filter" & Flash management would monitor the flash write status and pick up Hot Blocks
 - Hot Block means a block whose data is frequently updated
- Move "Hot (physical) Blocks" whose logical blocks are frequently updated into SLC area, for better performance & endurance
- Move 'Cold (physical) Blocks' whose logical blocks are less frequently updated into MLC, for storage

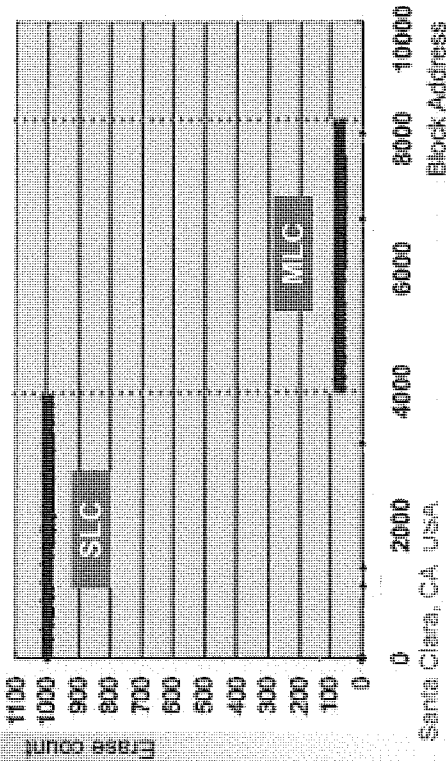




Hybrid Wear Leveling Result

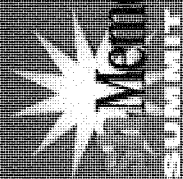


Test Result



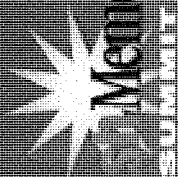
- Example: SM2240 (captured from FPGA)
- Program: Fill 5.5GB (6GB total). Copy 500MB data-> Compare ->Delete
- Flash Type: K9K8Gx2 + K9LBGx2

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An Overview on SMI Hybrid SSD

- SMI hybrid SSD SLC/MLC ratio is configurable depends on the targeted application(s).
- Assuming overall frequent data is 'X' GB: Hybrid SSD = X GB in SLC + (total capacity – X)GB in MLC
 - Through "SMI Hot Block Filter", 'X' GB frequent data will be automatically moved to SLC portion. Result in a hybrid SSD that performs as a pure SLC SSD in read/write & endurance, and save the cost difference with MLC.



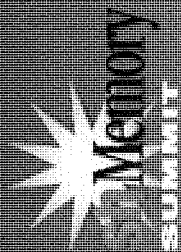
Hybrid SLC/MLC SSD Benefits

- For Example: a 72 GB hybrid SSD (8GB SLC + 64GB MLC).
 - In a typical consumer application: if frequent updated data size is ~ 8GB, through Hot Block Filter of the hybrid SSD, the 8GB hot data will mostly located in SLC flash.

Benefits

- Cost: fraction of pure SLC
- Performance: 2 times > pure MLC
- Endurance: 3 times > pure MLC
- Data integrity as SLC
- User experience as the SLC

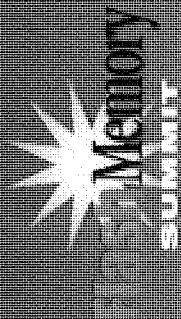
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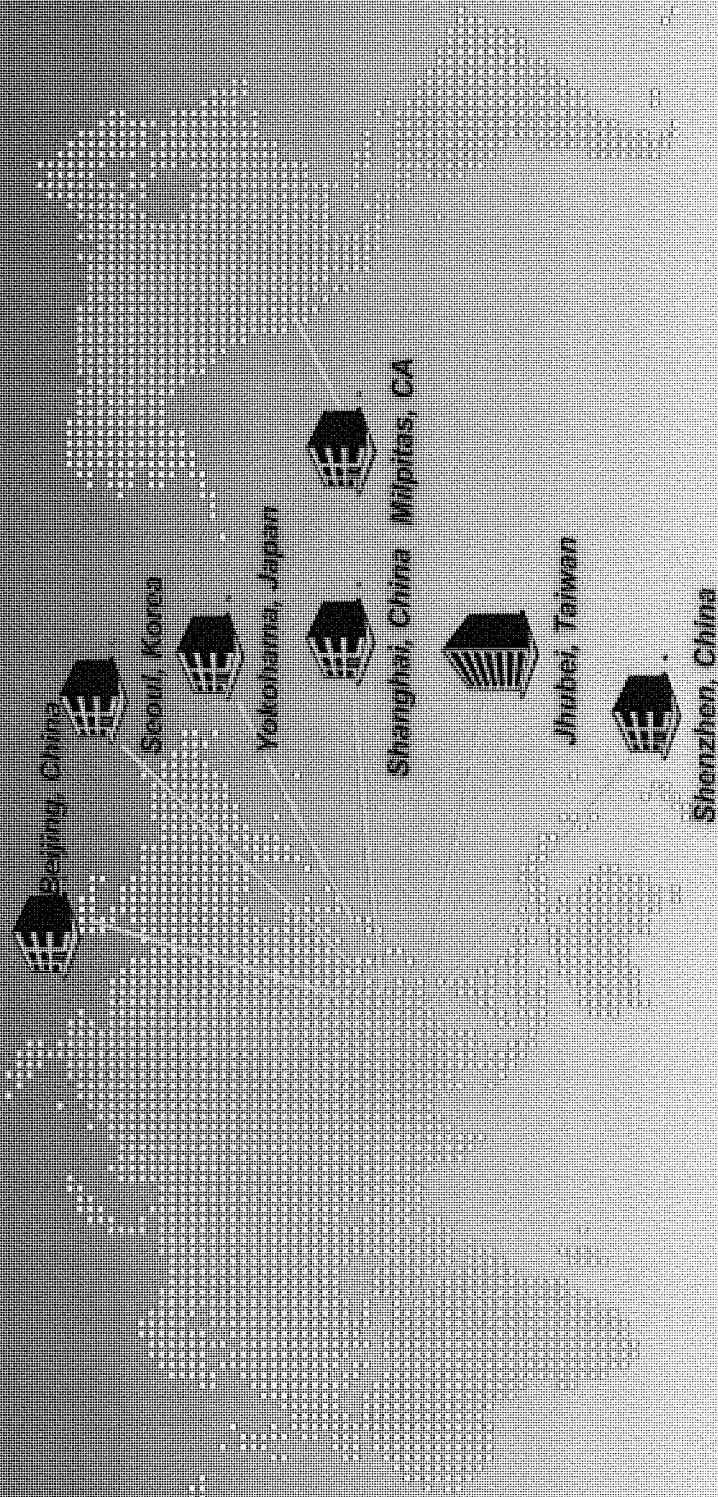
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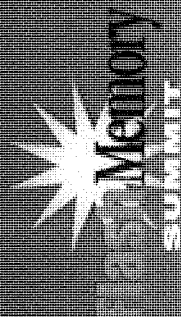


SMI WW Operations Support Global Focus



Headquarters: Jhubei, Taiwan
Other Operations: Seoul (Korea), Milpitas (USA), Shenzhen, and Beijing (China), Yokohama (Japan)
Employees: 600+ (380+ Engineers)
Distributors: N. America, Europe, China, Singapore, Taiwan, Korea, Singapore

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PATA/SATA SSD Product Roadmap

PATA



- CFA4.1 UDMA5
- 2-CH, 8 CE/ch
- R/W: 50/45 MB/s
- 4 bit RS ECC
- Static WL within MU
- MP: Now



- PATA, UDMA6
- 2-CH, 8 CE/ch
- R/W: 50/45 MB/s
- 13/24b 1KB BCH ECC
- Global WL
- MP: Q3'08



- PATA, UDMA6
- 4-CH, 16 CE/ch
- R/W: 100/80 MB/s
- 8bit BCH ECC
- Global Wear Leveling
- PATA- BGA-144
- MP: Q3'08

SATA



- SATA II, UDMA6
- 4-CH, 16 CE/ch
- R/W: 100/80 MB/s
- 8bit BCH ECC
- Global Wear Leveling
- SATA- QFP-128
- MP: Q3, '08



- SATA II, UDMA6
- 4-CH, 16 CE/ch
- R/W: 100/80 MB/s
- 13/24b 1KB BCH ECC
- Global Wear Leveling
- SATA- QFP-128
- MP: Q1, '09



- 32-bit RISC CPU
- SATA II, 8-CH, 16 CE/ch
- R/W: 200/180MB/s
- 13/24b 1KB BCH ECC
- External DRAM Buffer
- High Speed NAND
- MP: Q2 '09

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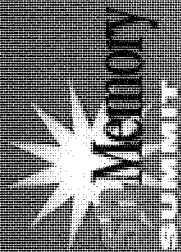
Q2, '08

Q3, '08

Q4, '08

Q1, '09

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Thank You!

Q&A

marketing@siliconmotion.com.tw

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