



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
August 2008

1



Agenda

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

Santa Clara, CA USA
August 2008

2



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



Performance concern

- 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) 	Slow access speed
Durability	Good endurance (10~20 times > MLC) 	Poor endurance (5K-10K program/erase)
Cost	Expensive (2-3 times > MLC)	Cheaper 

Why not combine SLC & MLC chips in SSD?



Agenda

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

Santa Clara, CA USA
August 2008

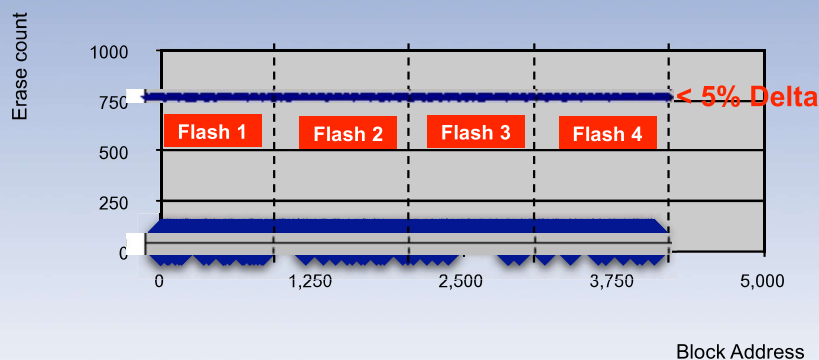
8



Global Wear Leveling Technology

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.

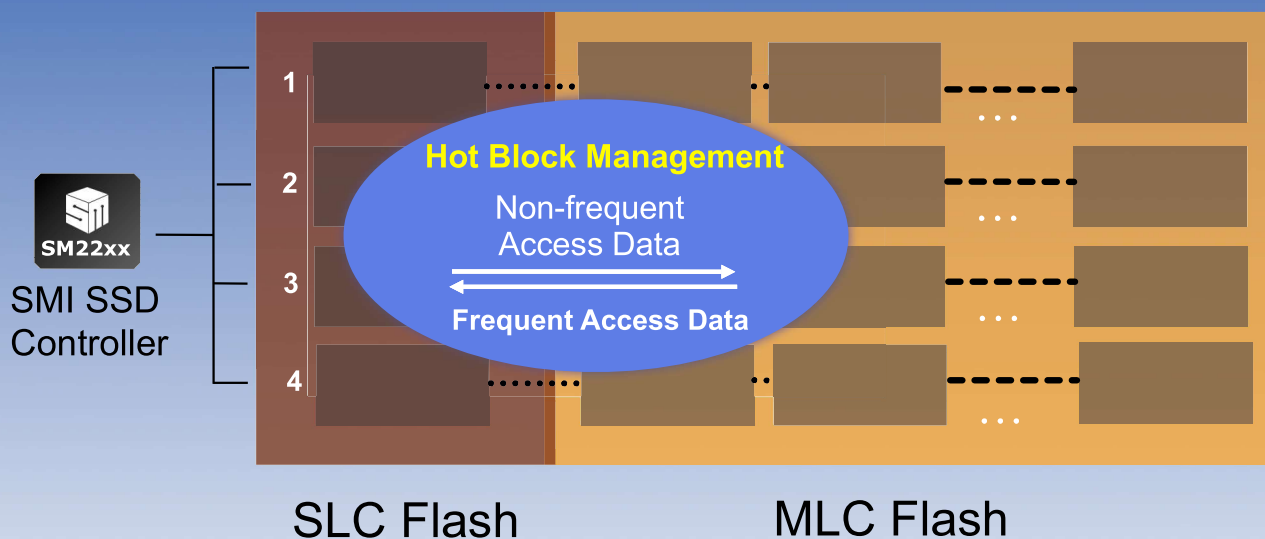


Example: SM2240
Program: Fill to 50% capacity, Copy
256M-> Compare >Delete
Flash Type: K9F8G08U0M x 4

Santa Clara, CA USA
August 2008



SMI SLC + MLC Hybrid Technology

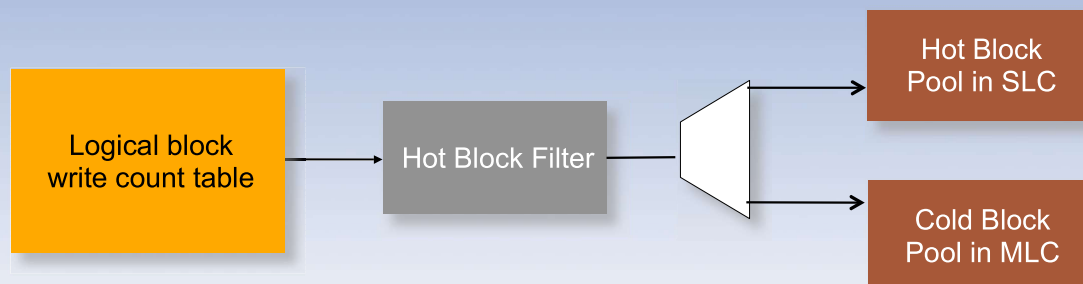


MLC cost with SLC performance and endurance!



Hybrid SSD Technology

- SMI'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



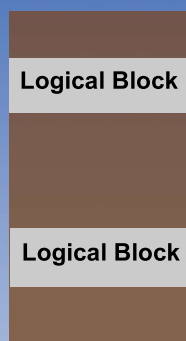
Santa Clara, CA USA
August 2008

11

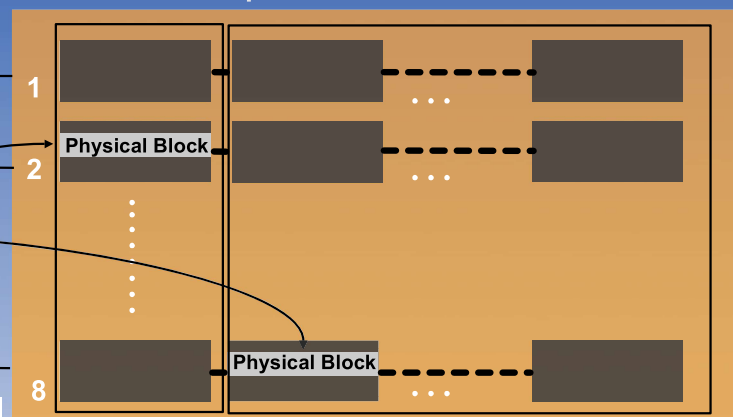


Hybrid Wear Leveling Result

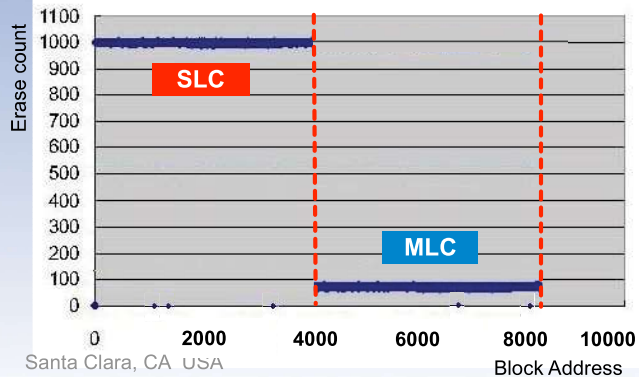
Host Logical Address



NAND Flash Components



Test Result



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



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



Agenda

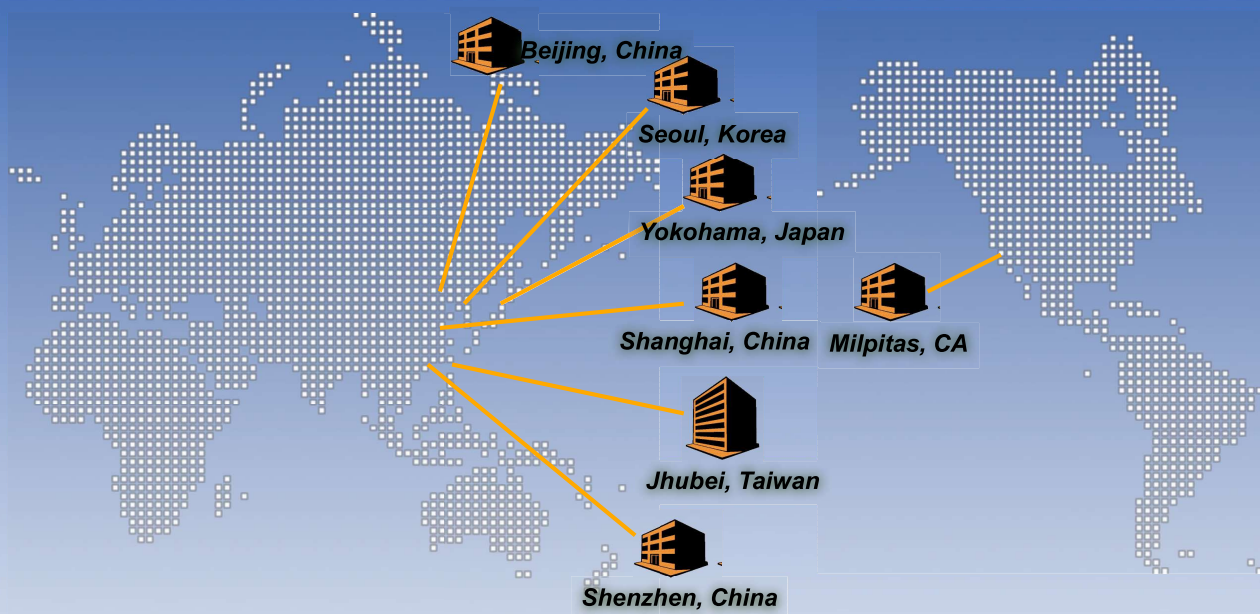
- **SSD Today & Challenges**
 - The Hybrid SLC + MLC concept
- **The Hybrid Technology**
- **About Silicon Motion**

Santa Clara, CA USA
August 2008

15



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

Santa Clara, CA USA
August 2008

16



PATA/SATA SSD Product Roadmap

PATA	Q2, '08			Q3, '08			Q4, '08			Q1, '09		
	 SM223 •CFA4.1 UDMA5 •2-CH, 8 CE/ch •R/W: 50/45 MB/s •4 bit RS ECC •Static WL within MU •MP: Now			 SM2231 •PATA, UDMA6 •2-CH, 8 CE/ch •R/W: 50/45 MB/s •13/24b 1KB BCH ECC •Global WL •MP: Q3'08			 SM2233 •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				 SM2240 •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			 SM2242 •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			 SM2250 •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		

Santa Clara, CA USA
August 2008

Q2, '08

Q3, '08

Q4, '08

Q1, '09

17



Thank You!

Q&A

marketing@siliconmotion.com.tw

Santa Clara, CA USA
August 2008

18