



Using MLC Flash to Reduce System Cost in Industrial Applications

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SMART High Reliability Solutions



Introduction

- Component selection: cost versus quality
- Use same component to repeat past success
- Works well until a technological shift occurs



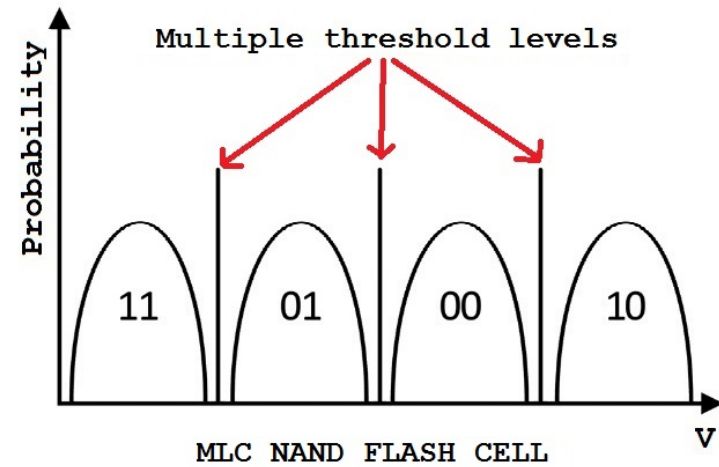
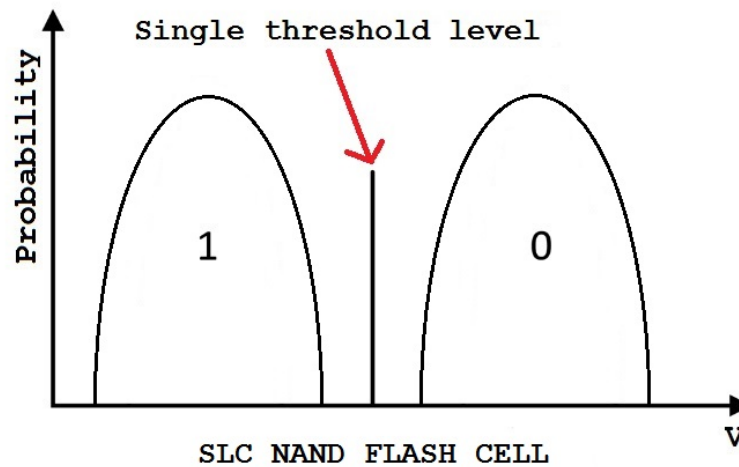
Introduction

- Industrial applications traditionally used SLC
 - For greater temperature range and endurance
- New improvements in MLC and controllers
- Still concerned with endurance and retention



Difference between MLC and SLC

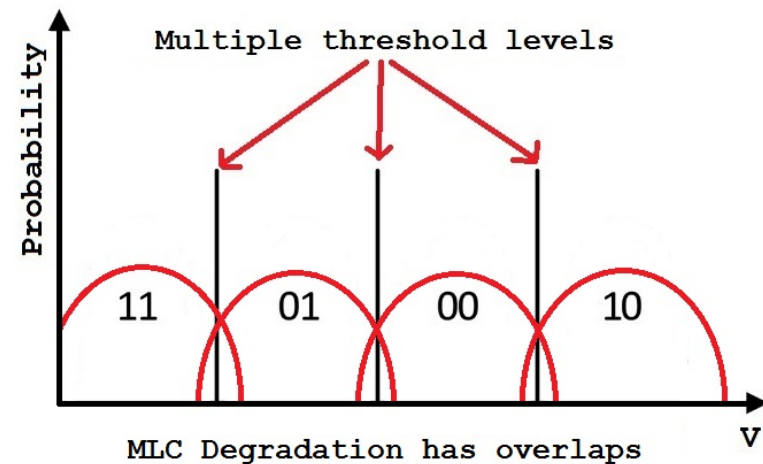
- Difference in voltage levels





Difference between MLC and SLC

- Difference in degradation
 - Two program operations
 - Overlaps cause errors



Difference between MLC and SLC

- Difference in write endurance
 - Typical 240GB MLC SSD endures 100-400 TBW
 - Typical 240GB SLC has 20 times the endurance
- Difference in retention
 - Varies depending upon drive age and temperature
 - At 85C, SLC drive can have 20 times the retention



Difference between MLC and SLC

- Difference in sensitivity to temperature
 - Hot:
 - Endurance is greater
 - Retention is lower
 - Cold:
 - Endurance is lower
 - Retention is greater
 - True for all flash, but worse with MLC than SLC





Recent Improvements

- NAND Flash technology improvements
 - Vendors now offer MLC for industrial temp range
 - Additional space for more error correction bits



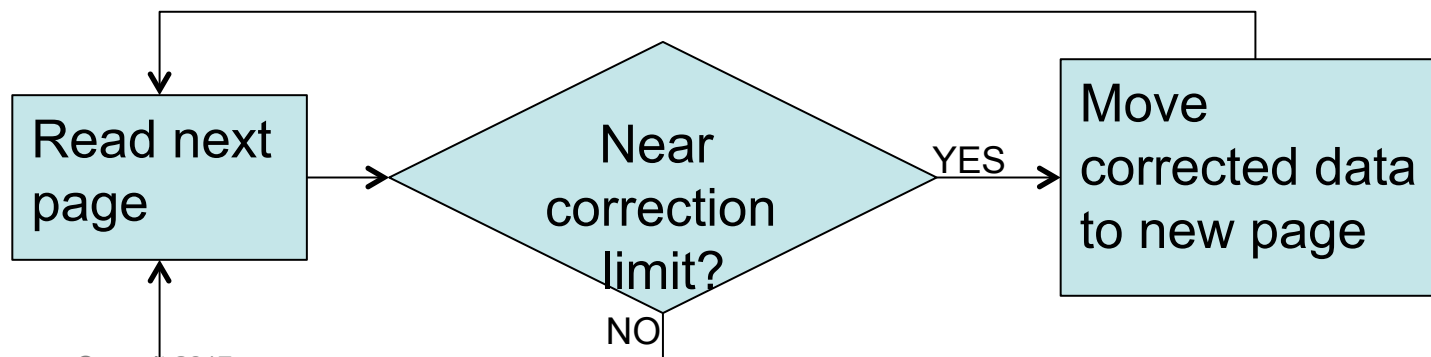
Recent Improvements

- NAND Flash controller improvements
 - Storing more bits for additional error correction
 - Improved error correction algorithms
 - Extraordinary error correction mechanisms



Recent Improvements

- NAND Flash controller improvements (cont.)
 - Improved wear-leveling algorithms
 - Read scrubbing helps extend retention



Endurance Requirements

- Impact of a file system
 - Meta data like filenames, timestamps, and pointers causes increased number of write operations
 - Sequentially writing a file is still random to SSD
 - Journaling (ext3 and NTFS) adds additional writes
- Raw disk access is an alternative



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Endurance Example

- Map display on 240GB MLC
 - Write a new 240GB map every day
 - Typical 240GB MLC SSD endures 100-400 TBW
 - Replace every 1 to 4.5 years



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Santa Clara, CA



Endurance Example

- Surveillance plane with 1920GB MLC
 - 8x capacity → 8x endurance = 800-3200TBW
 - Usually writes multiple streams with small data
 - More random access → 50 MB/s
 - 8-hour mission writing at 50MB/s → 1.5 TBW
 - If written every day, replace every 1.5 to 5 years

Endurance Example

- Transactional recorder with 1920GB MLC
 - Perhaps in a base station of cell phone tower
 - Non stop 24 hours per day, 7 days per week
 - Writing at 50MB/s → 4.5 TBW per day
 - With 3200TBW rating, replace every 2 years



Additional Selection Criteria

- Most industrial apps need more than I-temp
 - Rugged enclosure
 - Special military erase sequences
 - Write protection
 - Case isolation
 - Connectors with 30 uinches of gold

Additional Selection Criteria

- Grades of MLC
 - eMLC is MLC tuned to increase endurance
 - Disadvantage is reduced retention
 - Enterprise apps have uninterruptible power
 - Not much need for retention, and can use eMLC
 - Industrial apps cannot guarantee power and need decent retention as well as endurance



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Conclusion

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- Rugged industrial systems required SLC
 - Temperature and endurance
- Improvements in NAND flash
- Improvements in NAND controllers
- Increased capacity
- Lower cost of MLC can reduce system cost



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Conclusion



- SMART High Reliability Solutions
 - Has over 20 years of experience in rugged, solid-state storage
 - Has solutions for rugged military and industrial applications
- Find us in booth #627, or at pizza tonight, and ask us about MLC for industrial applications