

Tailor-made-SSD to Excel in Specified Storage Fields

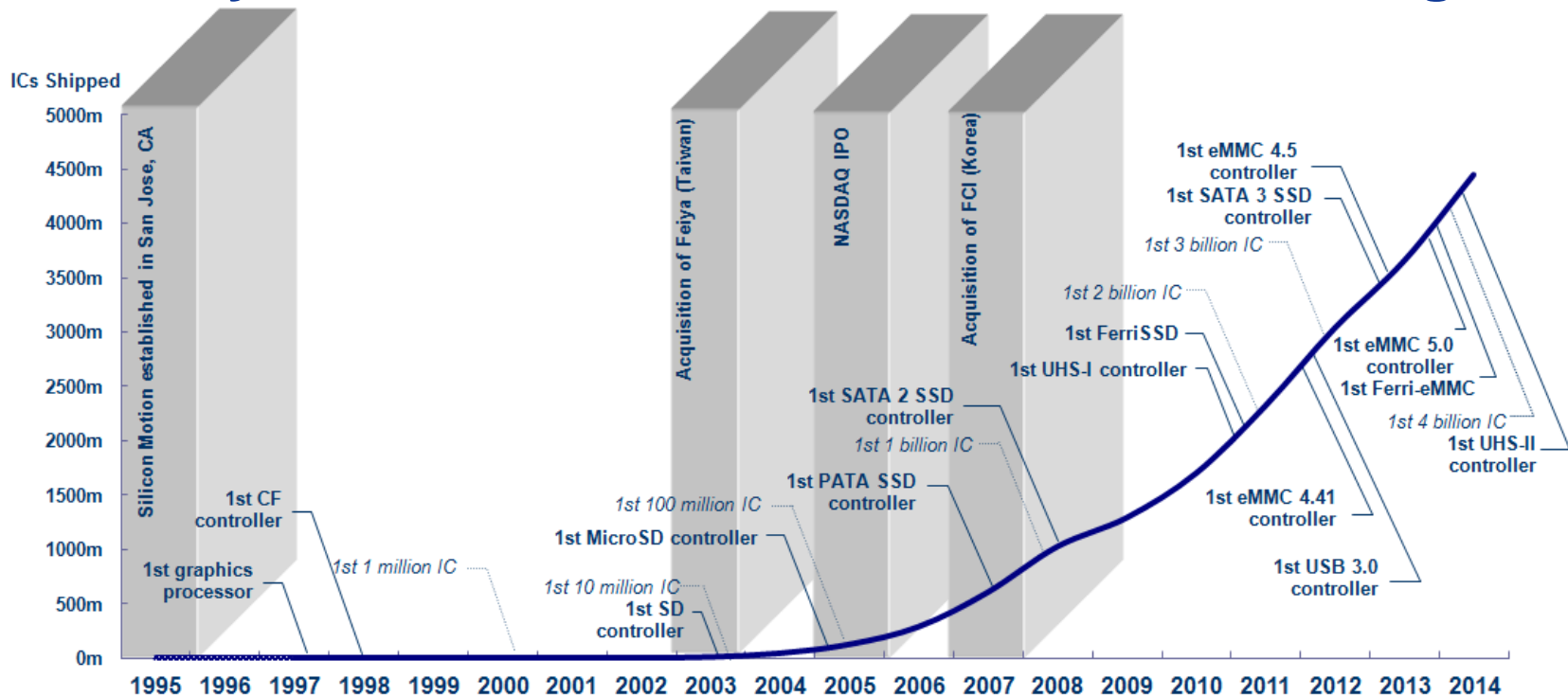
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Product Marketing Manager

Silicon Motion, Inc.

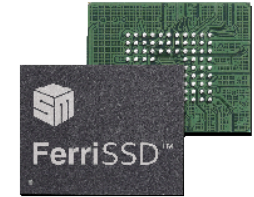
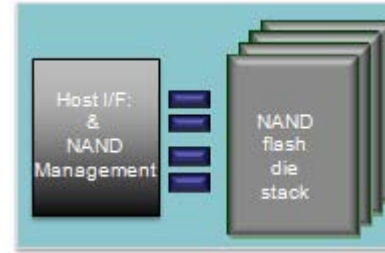
Background History: Silicon Motion Inc.

10+ years of contribution to NAND flash storage



Overcome embedded storage challenges

- Tailor-made-SSD
- All available host Interface
- Designed for embedded market
- **Customizing for your needs!**



Telecom & server



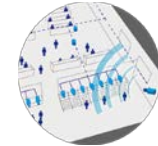
MFP



POS & Kiosk



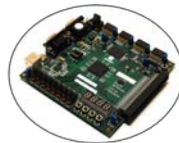
HMI/ Testing
Instrument



Surveillance System



Thin Client



Ind. / Embedded MB



In Vehicle
Infotainment



Medical Equipment



Can one SSD fit all application?

- A big density SLC SSD can probably satisfy some of the application requirements..
 - SLC offers the best Performance, Reliability, Endurance, Data retention, ...

Can SLC be the answer for every application??

The high price premium makes SLC unacceptable to most application..

Yet, there are still many other problems..



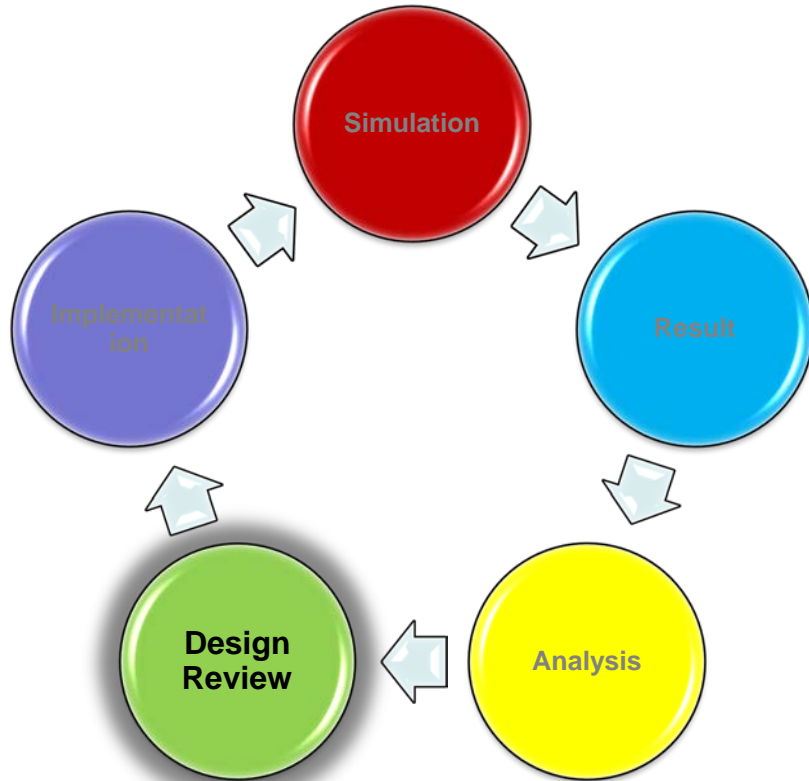
Tailor-make-SSD for each application



Requirements

- **Avoid downtime for Embedded System**
 - Simulation Model for Design Improvement
 - Eliminate Potential Defects (lower dPPM)
 - Remote Monitoring/Recovery System
- **Firmware Data Protection: Retention/Disturbance**
 - Read Intensive: 95/5% Read/Write ratio
 - Mixed Usage 66/34% Read/Write ratio
 - Write Intensive: 15/85% Read/Write ratio
- **System Level Protection Consideration**
 - System Level (Electrical) Protection
 - Sudden Power off Handling
 - Misc Package Level Protections

Actual Case Study – Design Review



Improve Quality for Embedded System

Goal: Lower than 50dPPM for SSD overall
Challenge: NAND Flash > 100dPPM

Firmware Data Protection on DR/RD

Goal: No Data Lost in > ~17 years
Challenge: Intensive Read vs Rarely access

Sudden Power off Handling

Goal: No Data Damage in the event of sudden power lost
Challenge: NAND Flash tend to have pair-page concern

Lowering dPPM – In Vehicle Infotainment



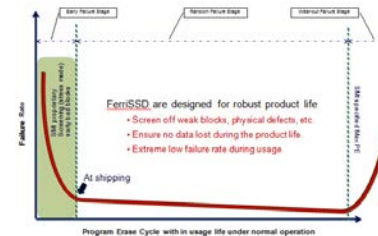
Production Chambers to simulate user operating temperature



Massive & effective setup for 100% in for each SSD before shipping

High/Low Temperature Burn-in Chamber

- Enable MP Level Screening to eliminate early weak blocks
- 100% Screen on every cell blocks at customer's specified operation temperature



Effective screen out all early failure parts in order to lower dPPM

Firmware protection – Retention/Disturbance

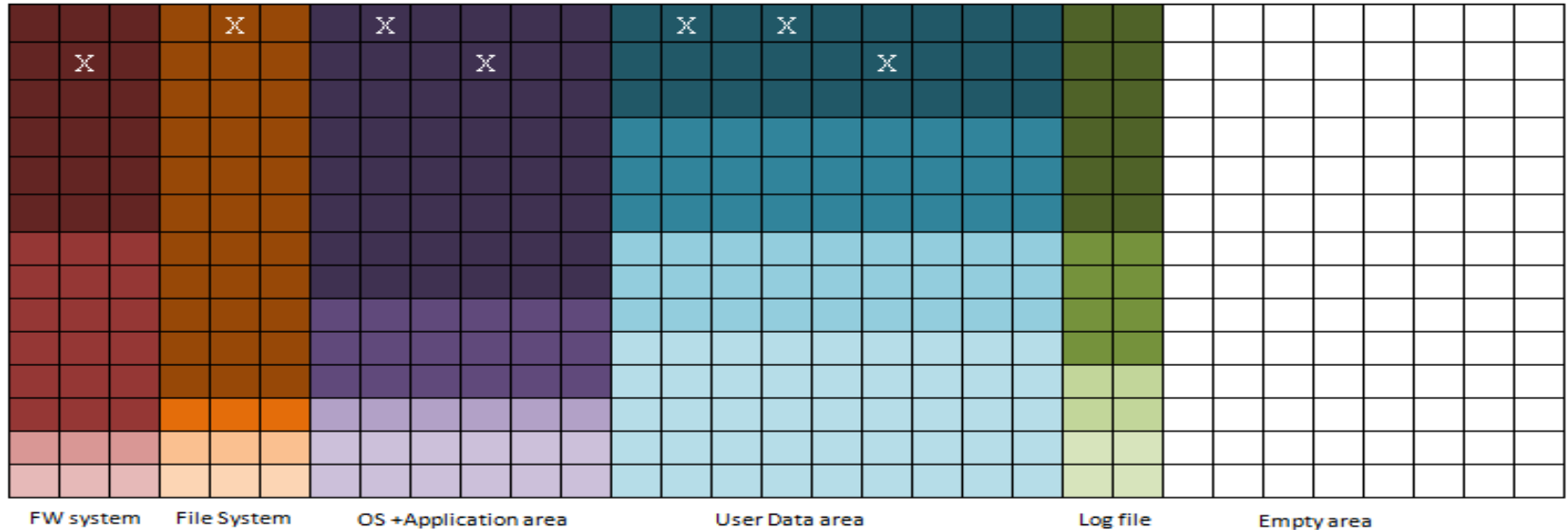



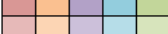

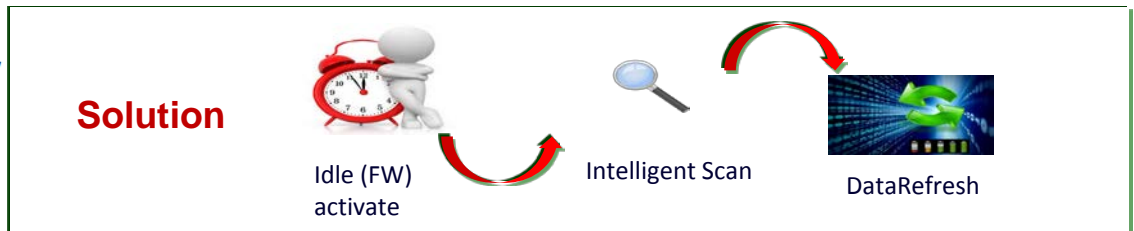
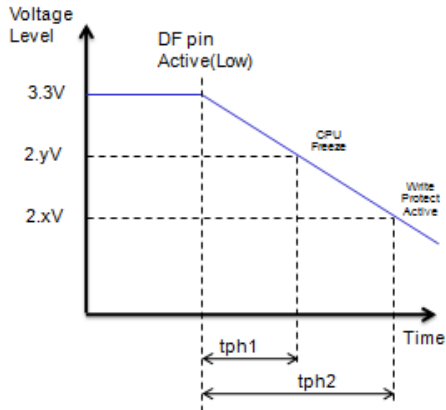
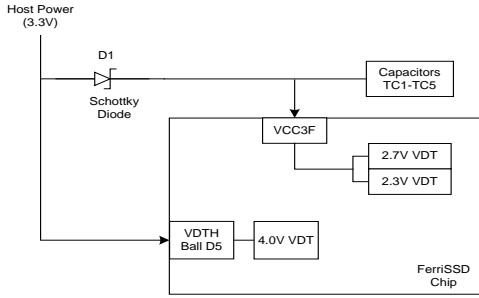


Illustration	Description
	= access extremely frequently
	= access hourly/daily
	= access weekly
	= access monthly
	= access yearly or less.



System Level Protection - Sudden power lost



FC*3 (without DF)

Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
...
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
SPOR when Data Write
Empty
Empty
Empty
Empty
Empty
Empty

FC*3 (without DF)

Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
...
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Lost to Pair Page
Data Lost to Pair Page
Data Lost to Pair Page
Data Lost to Pair Page
Data Lost to Pair Page
Data Lost to Pair Page
Data Lost to SPOR
Empty
Empty
Empty
Empty
Empty
Empty

FC*3 (without DF)

Valid Data
Valid Data
Valid Data
Valid Data
Valid Data
Valid Data
Valid Data
Valid Data
Valid Data
Valid Data
Valid Data
Valid Data
...
Valid Data
Valid Data
Valid Data
Valid Data
Valid Data
Valid Data
Valid Data
Data Lost to Pair Page
Data Lost to Pair Page
Data Lost to Pair Page
Data Lost to Pair Page
Data Lost to Pair Page
Data Lost to Pair Page
Data lost to SPOR
Empty
Empty
Empty
Empty
Empty
Empty

Standard SSD SPOR recovery method
DRAM cache - same as HDD & some pair-page data lost

FC*6 (with DF)

Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
...
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
SPOR when Data Write
Empty
Empty
Empty
Empty
Empty
Empty

FC*6 (with DF)

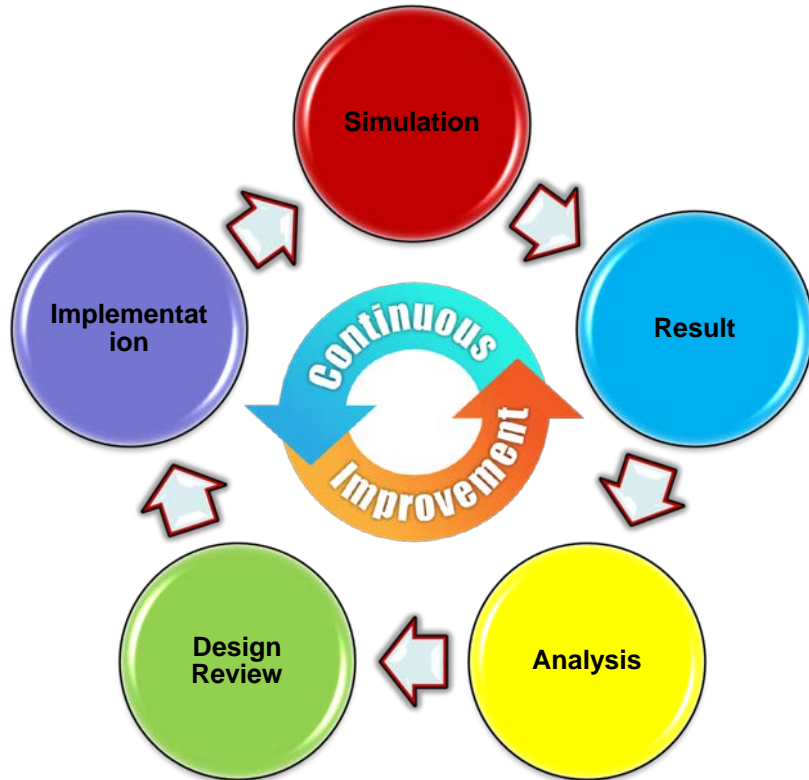
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
...
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Data Written
Allow Data Write finish
Empty
Empty
Empty
Empty
Empty
Empty

FC*6 (with DF)

Valid Data
Valid Data
Valid Data
Valid Data
Valid Data
Valid Data
Valid Data
Valid Data
Valid Data
Valid Data
Valid Data
Valid Data
...
Valid Data
Valid Data
Valid Data
Valid Data
Valid Data
Valid Data
Valid Data
FW scan keep as valid data at next power on
Empty
Empty
Empty
Empty
Empty
Empty

FerriSSD Data Flush SPOR recovery method
Data Flush pin or Module w/ capacitor (no data lost from SPOR)

Simulation Model – Continuous Improvement



Improve Quality for Embedded System

Goal: Lower than 50dPPM for SSD overall

Challenge: NAND Flash > 100dPPM

Solution: Hi/low Temp. Chamber to screen defect

Firmware Data Protection on DR/RD

Goal: No Data Lost in > ~17 years

Challenge: Intensive Read vs Rarely access

Solution: Firmware to Perform Scan & DataRefresh

Sudden Power off Handling

Goal: No Data Damage in the event of sudden power lost

Challenge: NAND Flash tend to have pair-page concern

Solution: Cost Effective Capacitance for Write to complete

Tailor-made-SSD to overcome challenges

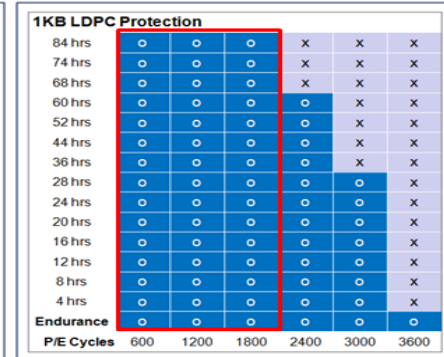
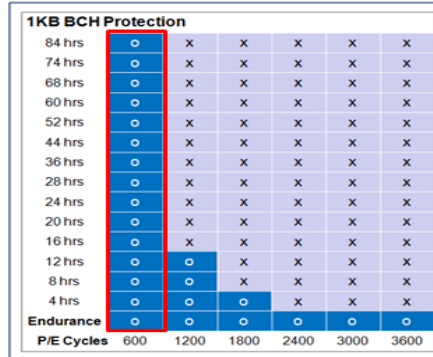
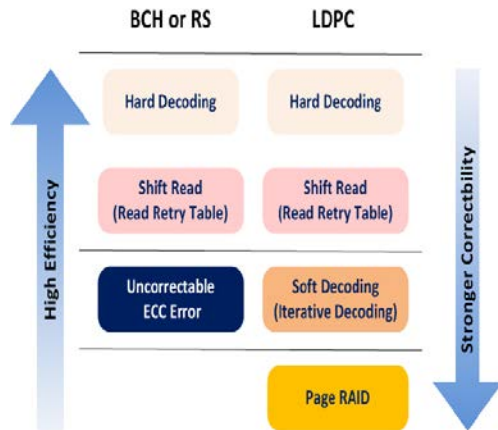


- **Data Integrity**
 - SSDLifeGuard
 - Intelligent Scan/DataRefresh
- **Performance**
 - Intelligent Clean
 - Energy Saving Mode
- **Security:**
 - FDE w/ Password
 - Secured Erase
 - Quick Erase
-

Continuously improving – Ready for the future



SLC -> MLC -> TLC -> 3D NAND -> QLC



Based on: 2ynm TLC, 120C baking



BCH vs LDPC

- Codeword level protection
- Improves PE/DR from 50% to 2x..

NANDXtend = LDPC + Page Raid
increase SSD life up to 3x

Page Raid

- Page level Protection
- Enables Raid-5 or Raid-6 protection

- Not one SSD type can satisfy all embedded application
- Case study:
 - Improve Quality for Embedded System
 - Firmware Protection on Retention & Disturbance
 - System Level Design Consideration
- Simulation for design confirmation & continuous improvement
- Tailor make SSD to excel in specified storage application!

Q & A ...

THANK YOU!

Email: ferri@siliconmotion.com

Visit us at the booth – 313

Disclaimer Notice

Although efforts were made to verify the completeness and accuracy of the information contained in this presentation, it is provided "as is" as of the date of this document and always subject to change.