SSD Technology and Architecture
Adding Value to Flash

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STEC-INC

The Challenge

- "Flash memory … is slowly being adopted for certain enterprise niche uses. However, its *write performance*, *cost* and *write endurance* will limit the extent to which it will replace disks on a large scale"

IBM Journal of R & D, July/September 2008 R. F. Freitas and W. W. Wilc

- STEC creates technologies that overcome the challenges of flash memory

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Addressing the Write Performance Challenge

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Addressing the Write Performance Challenge

- In 2007, STEC increased SSD's write performance from 300 IOPS to 18,000 IOPS
  - At 18,000 STEC's SSD write speed = 60-100 HDDs
- Key STEC innovations to solve the write performance challenge
  - Log Structured File System
  - DRAM Write Back Cache

Impact of High Write Performance

- Improving write performance enabled SSDs to become the Tier 0 Storage solution
  - Today all major storage suppliers provide Tier 0 storage solutions
- The next challenge
  - Cost

Addressing the Cost Challenge

- First Generation SSD cost challenges

	Solutions
• 1 bit per cell (SLC) flash technology	→ MLC
• Large geometry flash	→ Geometries of 3xnm and below
• FPGA based platform	→ ASIC

- Solution to each one of these challenges, comes with its own new challenges

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Addressing the MLC Challenge

- MLC delivered lower cost, but adversely impacted reliability and performance
  - Slow Write Performance
  - Low Write Endurance
  - Higher Bit Error Rates

Solutions

→ Increase the number of active die

→ Extend the write endurance

→ Lower the bit error rate

Addressing the MLC Challenge

- MLC delivered lower cost, but adversely impacted reliability and performance
  - Slow Write Performance
  - Low Write Endurance
  - Higher Bit Error Rates

→ Interleave Support

STEC CellCare™ Technology

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Impact of Mitigating MLC Issues

- MLC SSDs require high write endurance to support enterprise-class workloads of 10x writes per day
  - STEC MLC drives come with the same 5 year warranty as SLC drives
- SSDs need to deliver consistent performance throughout the life of the drive
- STEC's MLC drives outperform many SLC drives

Addressing the Small Geometry Flash Challenge

- Challenges with MLC built in 3x nm and smaller geometries
  - High Flash Failure rate
  - Data Retention
  - Read Disturbance

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Addressing the Small Geometry Flash Challenge

- Challenges with MLC built in 3x nm and smaller geometries

	Solutions
• High Flash Failure rate	→ Parity protected data
• Data Retention	→ Firmware improvements
• Read Disturbance	→ Firmware improvements

Addressing the Small Geometry Flash Challenge

- Challenges with MLC built in 3x nm and smaller geometries

	Solutions
• High Flash Failure rate	→ SAFE
• Data Retention	→ Advanced Firmware
• Read Disturbance	→ Advanced Firmware

Impact of SAFE and Advanced Firmware

- Small geometry Flash with parity protected data can deliver the *same* reliability as large geometry flash
  - 2 Million hour MTBF specification
- With Advanced Firmware, MLC drives can deliver the same data reliability as SLC drives
  - STEC's MLC SSDs are used in the most demanding environments

Addressing the FPGA Platform Challenge

- Challenges associated with FPGA based platforms
  - Higher cost and power
  - Limited ability to differentiate

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Addressing the FPGA Platform Challenge

- Challenges associated with FPGA based platforms

	Solutions
• Higher cost and power	→ Integrated ASIC
• Limited ability to differentiate	→ Unique features & capabilities

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Impact of a Custom ASIC

- Can provides SSD suppliers with a strong low cost platform to deploy a broad range of products using a common architecture
- Differentiation
  - Advanced Power management
    - Delivers higher performance for a given power budget
  - Advanced Error Correcting Code delivers more correction power for the same format overhead

Impact of Flash Innovations

- Markets for SSDs are expanding
  - STEC and other supplier's innovations have driven major enhancements in cost, performance and reliability, enabling the advent of pure SSD Storage
- SSDs are making major inroads into volume server markets
  - Replacing HDDSs
  - Finding new application for caching and extension of processor memory

Summary

- SSD technology and innovations add significant value to Flash
  - Performance
  - Cost
  - Data integrity and reliability
  - Write endurance

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Thank You