LSI® SandForce® SF3700 Flash Controller

LSI
Storage.
Networking.
Accelerated.™

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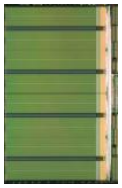
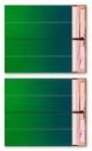
November 2013

NAND Flash Evolution: Capabilities & Characteristics

LSI

Flash Benefits


34nm


24/25nm


20/19nm


1x/1ynm

Benefits

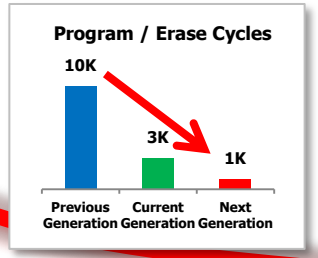
- Lower $/GB Cost
- Higher Capacity
- Higher Unit Volume

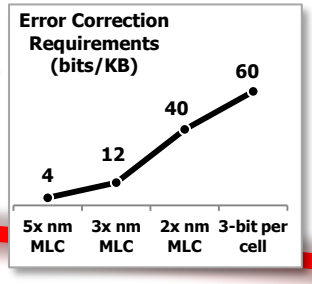
Growing Dependence on Flash Controller to Close Gap

Flash Challenges

- All flash is different and changes every 18 months!
  - Endurance, Reliability, Performance, Interface

SAMSUNG TOSHIBA SK hynix SanDisk Micron intel





Challenges

- Shorter Endurance
- Performance w/less die
- Lower Reliability
- Higher ECC Req.
- Evolving Flash Types

Time

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Introducing the LSI SandForce SF3700 Flash Controller

- Newly engineered to solve the latest challenges of NAND Flash
- Designed for both Enterprise and Client markets
- Provides native PCIe and SATA interfaces in a single ASIC
- Builds on the award winning technology of current SandForce Flash Controllers
- OEM SSD manufacturers bringing up designs now; mass production expected 1H'14

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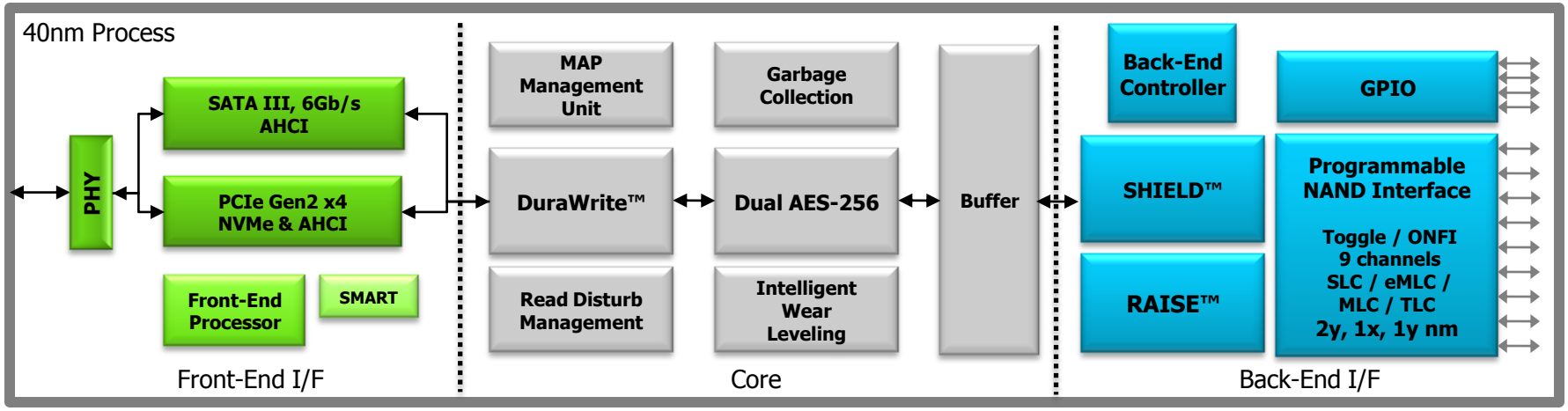
SF3700 Flash Controller

New modular and flexible design best supports evolving flash types

Solves NAND Issues

- Evolving Flash Types

- Modular/Flexible Architecture Enables:
  - Single ASIC with multiple host interfaces
  - Ability to support new host interface features
  - Support for new Flash modes
  - Continuous innovation through product life
- Benefits
  - Faster time to market
  - Better cost and inventory management
  - Extended product life
  - Richer product portfolio



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SF3700 Product Family

SF3719

Entry Client

SATA + x2 PCIe

SF3729

Mainstream Client

SATA + x2 PCIe

SF3739

Enthusiast Client
Value Enterprise

x4 PCIe + Full Power Fail

SF3759

Enterprise Caching
Enterprise Storage

Scalable PCIe
Full Enterprise Feature Set

Power Optimized ⟶ **Performance Optimized**

Supported Firmware Features

$ ⟶ **Market Pricing** ⟶ **$$$**

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SF3700 Performance
Random and Sequential

Solves NAND Issues
• Performance w/less die

- These SF3700 results assume 100% entropy (worst case)

PCIe Performance	SF3700 (256GB) MLC		Samsung XP941 (512GB) MLC*	
Testing Conditions	Early FW FOB 100% Entropy	LSI Spec 8GB Span 100% Entropy	3rd Party Review FOB	Mfg. Spec FOB
Rnd Read (IOPS)		150K	82-99K	122K
Rnd Writes (IOPS)		81K	60-70K	72K
Seq Reads (MB/s)	1450	1800	986-1134	1400
Seq Writes (MB/s)		1800	677-935	970

SATA Performance	SF3700 (256GB) MLC		Samsung 840 Pro (256GB) MLC*	
Testing Conditions	Early FW FOB 100% Entropy	LSI Spec 8GB Span 100% Entropy	3rd Party Review FOB	Mfg. Spec FOB
Rnd Read (IOPS)	90K	94K	91K	100K
Rnd Writes (IOPS)		46K	70K	78K
Seq Reads (MB/s)	562	550	413	540
Seq Writes (MB/s)		502	373	450

Optimizing performance as Flash geometry shrinks

*Sources: http://www.anandtech.com/show/6328/samsung-ssd-840-pro-256gb-review/1, http://www.thessdreview.com/our-reviews/samsung-xp941-m-2-pcie-ssd-review-512gb/, http://www.samsung.com/global/business/semiconductor/news-events/press-releases/detail?newsId=12921

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SF3700 Latency

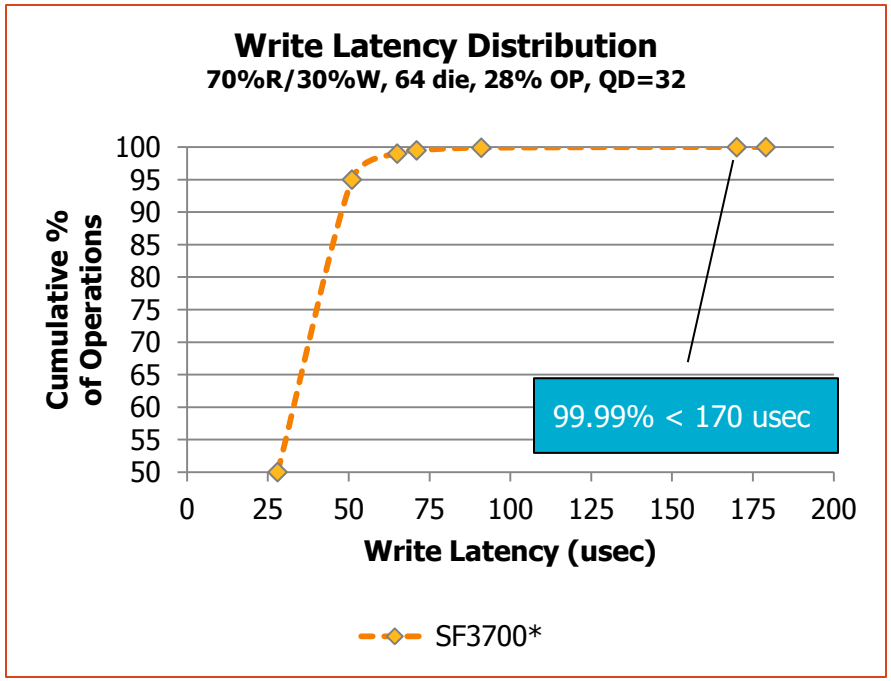
Predictable latency is key for datacenters

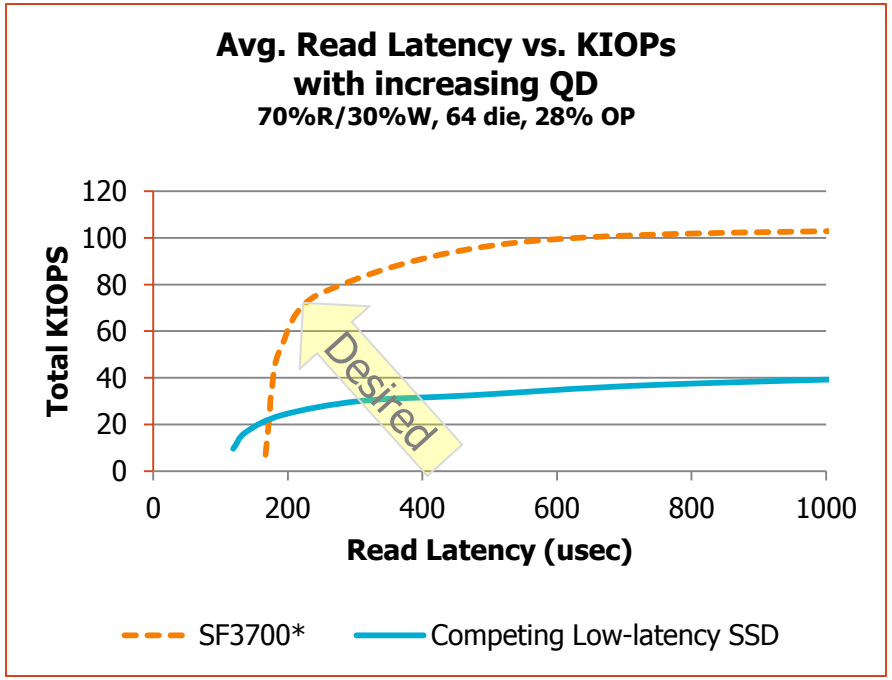
Solves NAND Issues

- Performance w/less die

Write latency should hit 100% as quickly as possible

Read latency should stay vertical as long as possible





- Flash performance trades off Latency vs. IOPS: IOPS = QD/latency

* Performance Model

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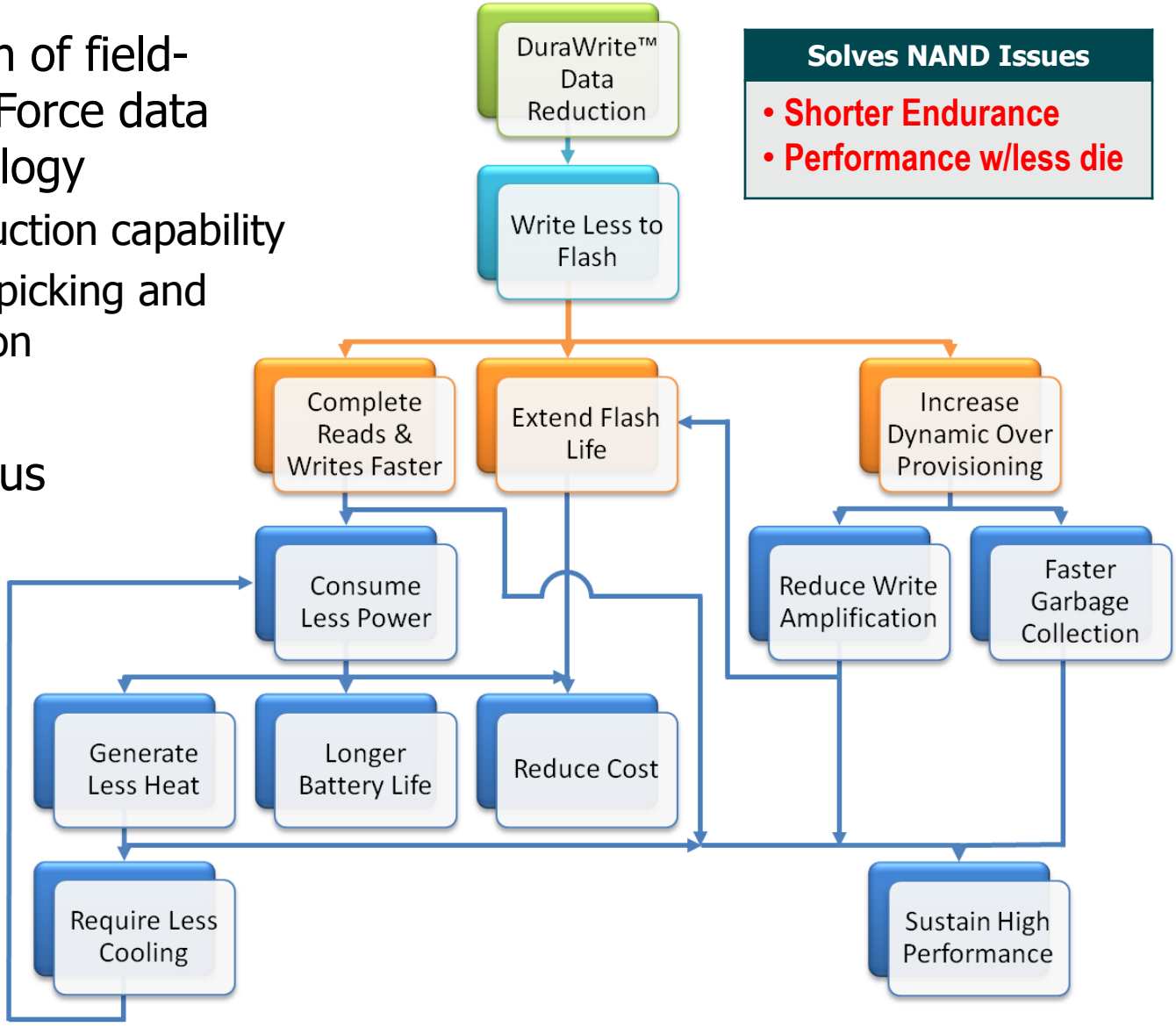
DuraWrite™ Data Reduction – SF3700 Improvements

- Enhanced version of field-proven LSI SandForce data reduction technology
  - Higher data reduction capability
  - Improved block picking and garbage collection
- Provides numerous advantages for typical data
- Includes many recursive benefits



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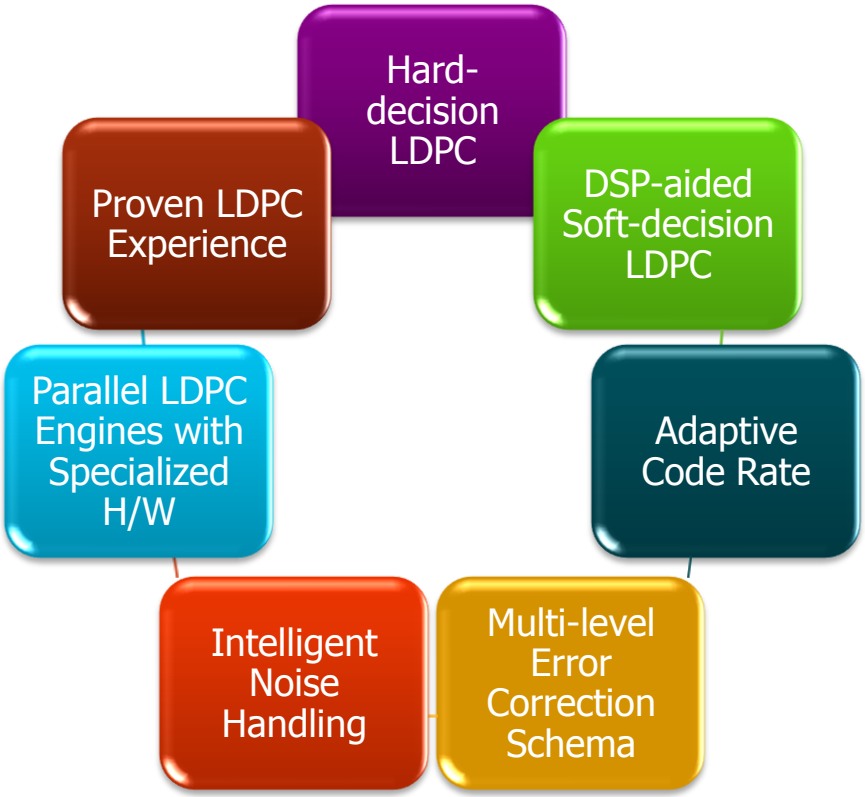
SHIELD™ Error Correction Technology

Advanced Low-density Parity Check (LDPC) for Flash Storage

- The strongest SSD ECC available today
- Applies progressively stronger decoding methods as necessary

Solves NAND Issues

- Lower Reliability
- Higher ECC Req.
- Evolving Flash Types



SHIELD technology uniquely combines a number of features and correction techniques

Don't be fooled by other LDPC solutions

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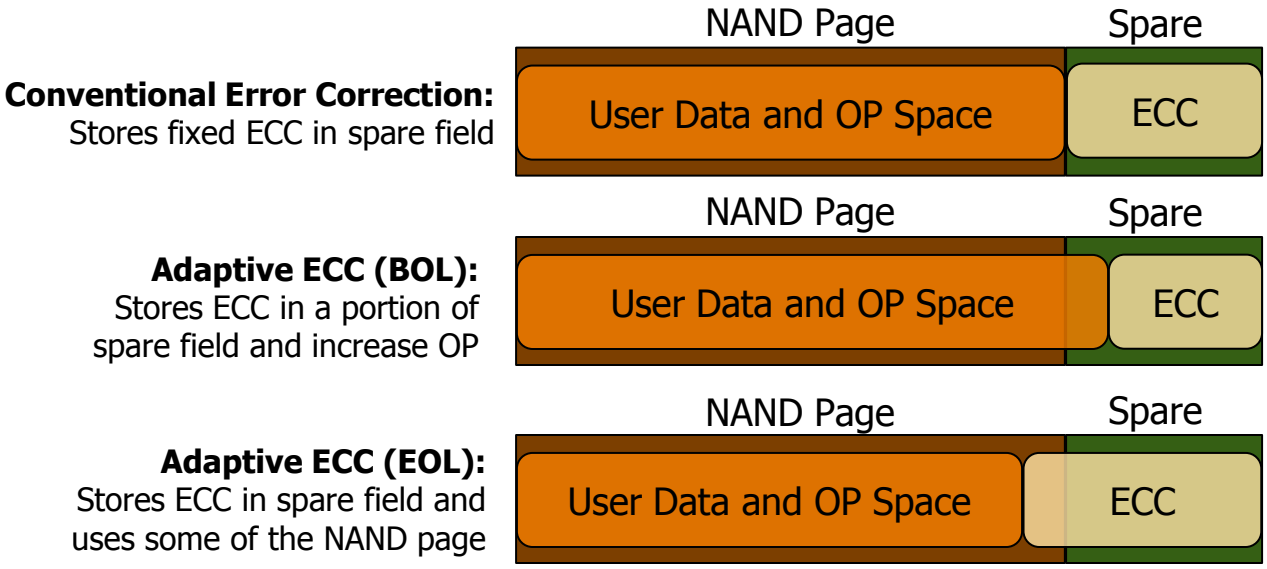
SHIELD Error Correction Technology
Adaptive Code Rate

Solves NAND Issues
- Lower Reliability
- Higher ECC Req.
- Evolving Flash Types

- Flash at beginning of life (BOL) is more robust; requires less ECC
- Leverages DuraWrite™ Flash Translation Layer to dynamically change Spare area
- Gives extra spare ECC field to OP and increase performance / endurance
  - Up to 3% more OP (as much as 41% more total OP*)
- As drive reaches end of life (EOL), SHIELD increases ECC to maintain readability and increase endurance beyond NAND spec



Adaptive ECC allows for more free space @ BOL = Higher Performance / Endurance

*Based on physical OP change = (3 / 7.37)

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RAISE™ Data Protection SF3700 Enhancements
(Redundant Array of Independent Silicon Elements)

Solves NAND Issues
• Lower Reliability

- RAISE protects data from unrecoverable ECC failures
  - If SHIELD ever failed, RAISE would step in to protect the data

RAISE Levels	Description	Failures Protected	Die Used	Correctable Elements	Probability of data loss
1 (Original)	Protects against failures in higher die-count configurations	Single page & block	1	1	Lower
2 (New)	Protects against full die failures with additional die or high OP	Multiple page & block, & single die	2	2	Lowest

- New Options
  - Auto-Reallocation – RAISE Level 2 Option
    - After a die failure either:
      1. Another die can be automatically allocated to protect against an additional die failure (reduces OP)
      2. The affected data can be moved into a RAISE level 1 configuration without using another die
  - Fractional RAISE – RAISE Level 1 Option
    - Protects against failures in lower die-count configurations; uses less than a full die
  - Optional 9th Flash channel for an extra die enables RAISE protection when providing full binary user capacity

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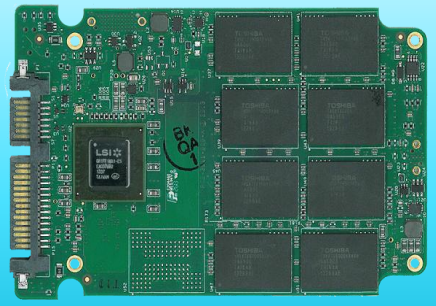
Key Feature Summary

SF3700 Features	User Benefits	Flash Challenge Solved
• DuraWrite Enhancements	• Higher Performance • Longer Endurance	• Shorter Endurance • Performance w/less die
• SHIELD Error Recovery	• Higher Data Reliability • Longer Endurance	• Lower Reliability • Higher ECC Req. • Evolving Flash Types
• New RAISE Levels and Options	• Higher Data Protection	• Lower Reliability
• Flexible, modular architecture	• Adaptability to future Flash	• Evolving Flash Types
• Low, predictable latency	• Consistent performance to meet SLAs	• Performance w/less die

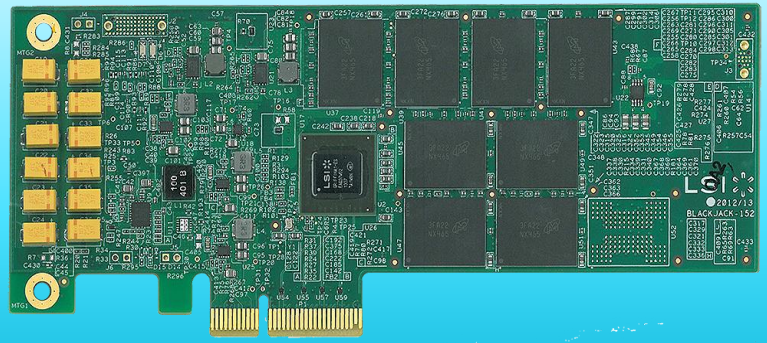
Engineered to solve the challenges of NAND Flash

SF3700 Reference Design SSDs

M.2 2280
SATA 6Gb/s
PCIe Gen2 x2

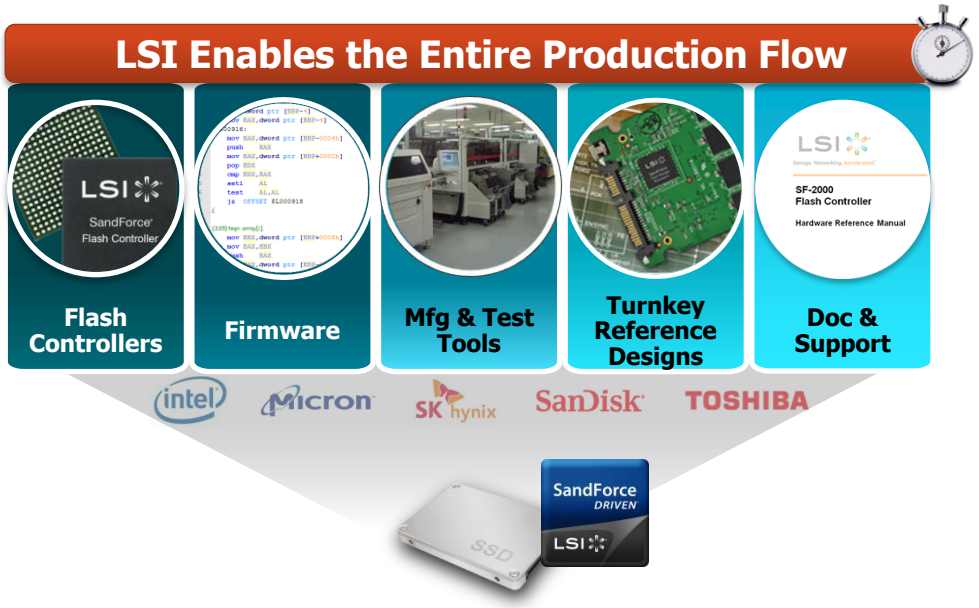


2.5”
SATA 6Gb/s
PCIe Gen2 x2



HHHL
PCIe Gen2 x2/x4

- Fastest time-to-market with largest selection of flash vendors
- Widest selection of form factors (standard / custom)
- DRAM-Less design enables many other options
- Directly engage with flash, drive, system OEMs & cloud service providers



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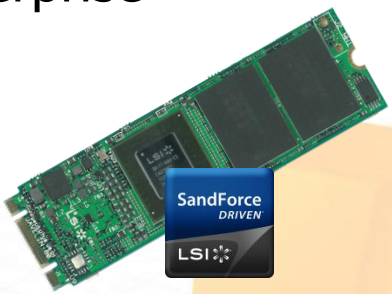
LSI DuraClass™ Technology Optimizes Data Storage

- **Reliability** – RAISE™ and SHIELD™ technology, End-to-End protection
- **Endurance** – DuraWrite™ technology, MLC flash in Enterprise
- **Single-Chip** – DRAM-less, super dense designs
- **Performance** – Low latency with low CPU utilization
- **Extensive Manageability** – Simple IT management
- **Drive Level Security** – Safe Data Storage without Compromises
- **Capacity Density** – More bits in small systems
- **System Efficiency** – Best total performance per watt
- **Flexible Power Management** – Increased battery life



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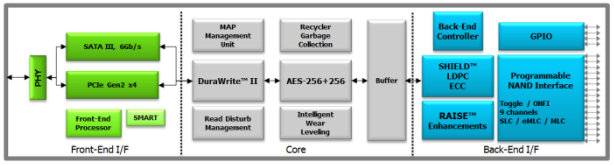
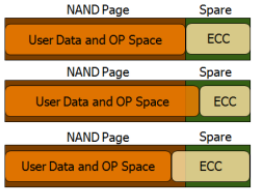
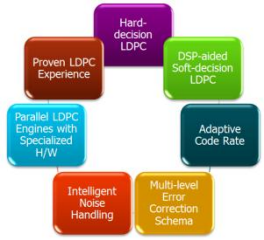
LSI SandForce SF3700 Flash Controller

- Newly engineered to solve the challenges of NAND Flash



- Expanding award-winning DuraClass technology
  - SHIELD advanced LDPC error correction
  - DuraWrite data reduction improvements
  - RAISE data protection enhancements





RAISE Enhancements
New RAISE Level 2
Auto-reallocation
Fractional RAISE

- Continuing a proven business model
  - Complete turnkey solutions
  - Wide Flash memory support

intel Micron SK hynix SanDisk TOSHIBA

Accelerating the Growth of SSD Deployments

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Live Demonstrations

- LSI will be running live demonstrations of the SF3700 at two events:
  - Supercomputing 2013
    - November 18-21; Denver, Colorado
  - Accelerating Innovation Summit 2013
    - November 19-21; San Jose, California

- LSI partners showing SF3700 demonstrations at AIS include:

ADATA

AVANT Technology

Kingston TECHNOLOGY

- Demonstrations include Toshiba A19nm and Micron 20nm Flash

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