SSD with Hybrid NAND

Smart Controller pushing price barrier

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Which Metric Matters Most?

- Small Size Performance Matters
- Fast 4KB Performance is Better

Window 7 typical user workload analysis

- Does Performance Scale Go Linearly with What Users Feel?

*Source: Sandisk_20100817_F1B_Tailoring SSD Architectures to Meet Evolving PC User Requirements_OrenKlein*
Which Metric Matters Most?

- Lots of Performance Comparison with HDD

- But no comparison between SSDs
What If the SSD Were Infinitely Fast?

- Cached DRAM data represent infinitely fast drive

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Test system: Intel® Core™ i7-2600 8MB L3 3.4GHz P67, 4GB DDR3
DRAM SSD Simulation Test Method: Launch an application to cache it in the dram and then exit & re-launch to measure the application launch time.
Intel S320 300GB SSD is used for SSD. Seagate Momentus* 7200 rpm ST9500420AS 500GB is used for HDD
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Difference between SSD and infinitely fast drive is small!!
What Really Matters Today?

- Price were, is and will be the Key Driver
Any Room for Price Reduction without Trading off Performance

- Source: Price reference from Newegg.com
Any Room for Price Reduction without Trading off Performance

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Various NANDs in Today’s Market

- **SLC NAND**
  - High Reliability and Endurance
  - High Price and Performance

- **Clear NAND**
  - Built-in ECC & Signal Processing
  - Less burden for controllers

- **Enterp. Grade MLC Synch**
  - Improved Reliability
  - Improved Endurance

- **Synch/Toggle MLC NAND**
  - High Speed Interface
  - Small Premium Price

- **Asynch MLC NAND**
  - Consumer NAND
  - Mass Market

- **TLC NAND**
  - Less Reliability
  - Low Price for SD Cards
New Segments with Hybrid NAND

- SLC NAND
- Clear NAND
- Enterp. Grade MLC Synch
- Synch/Toggle MLC NAND
- Asynch MLC NAND
- TLC NAND

- Benchmark is performed with CrystalDiskMark3.0* and PCMark05 Vantage. / Test system: Intel® Core™ i7-2600 8MB L3 3.4GHz P67, 4GB DDR3
- SATA 3,128GB SSDs are tested. One with 25nm Synch NAND and the other with 34nm Asynch NAND.
- Hybrid NAND SSD performance is projected performance with internal simulation result.
New Segments with Hybrid NAND

Increasing Performance, Reliability & Price

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Smart Controller is Key to New Price Segment

- Source: Price reference from Newegg.com
Smart Controller is Key to New Price Segment

- 128GB Score: 55K
- 320/128GB Score: 32K
- Source: Price reference from Newegg.com
New Segments with Hybrid NAND

- SLC NAND
- Clear NAND
- Enterp. Grade MLC Synch
- Synch/Toggle MLC NAND
- Asynch MLC NAND
- TLC NAND

Increasing Performance, Reliability & Price

At Small Capacity SSD
SLC like Product Life & Performance
With MLC like Price
New Segments with Hybrid NAND

- **Mainstream SSDs**
  - SLC NAND
  - Clear NAND
  - Enterp. Grade MLC Synch
  - Synch/Toggle MLC NAND
  - Asynch MLC NAND
  - TLC NAND

- **Hybrid**
  - SLC like Performance
  - TLC like Price

Increase Performance, Reliability & Price
Reliability and Product Life Improvement with Hybrid NAND

Probability of Bit Error (After ECC)

Acceptable Error Rate for Client Application
Reliability and Product Life Improvement with Hybrid NAND

Advanced adaptive algorithm to filter ‘frequently’ & ‘Infrequently’ accessed data to enable Hybrid NAND configuration.
Reliability and Product Life Improvement with Hybrid NAND

- **MLC**
- **SLC**
- **Increase Useful Life**
- **Increase Data Integrity**

Graph showing the probability of bit error (after ECC) versus read cycle and P/E cycle with different technologies. The graph indicates a significant improvement in reliability and product life with the use of MLC and SLC technologies combined.
Reliability and Product Life Improvement with Hybrid NAND

- **TLC**
- **SLC**
- **SLC + TLC**

- **Increase Useful Life**
- **Increase Data Integrity**

- **Read Cycle**
- **P/E Cycle**

- **Probability of Bit Error (After ECC)**

- **Flash Memory Summit**
- **NOVA CHIPS**

- **Advanced adaptive algorithm**
New Segments with Hybrid NAND

- **SLC NAND**
- **Clear NAND**
- **Enterp. Grade MLC Synch**
- **Synch/Toggle MLC NAND**
- **Asynch MLC NAND**
- **TLC NAND**

Hybrid NAND SSD

Flexible Configuration

For Market NEEDS

Increasing Performance, Reliability & Price
New Segments with Hybrid NAND

Smart SSD Controller can flexibly configure various NANDs from today’s market.

Not only it can expand the market by pushing the price barrier but also create new market segments according to various market needs.
Thank you

For Any Questions;
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