The Evolving NAND Flash Business Model for SSD

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Agenda

- SSD – Enabling Price Points are key!
- Reliability – Need adaptive ECC
- Reliability – Cluster Failure Mitigation
- Soft-interface Evolution for NAND
- Evolving NAND business model
SSD – Enabling Price Points are key!

- SSDs deliver a value proposition around $/IOPS/W/in^3, latency, form factor and robustness not $/GB.
- But enabling price points matter!

- CY09: SLC Enterprise SSD less than $20/GB => Storage Systems
- CY10: MLC Enterprise SSD less than $5/GB => Servers
- CY11: MLC Enterprise SSD less than $5/GB => Storage Systems
- CY12: MLC SATA SSD less than $1/GB => Client Compute Systems
Reliability – Need adaptive ECC

- SSD require highest reliability amongst NAND apps
  - Smaller lithography and increased MLC enabled NAND cost reductions, a side effect is a higher raw bit error rate
  - BCH based technologies reaching their technology scaling limits requiring increasing NAND spare area for ECC usage (>10%)
  - SSD processors are expected to support up to 80b/1kB ECC in order to enable reliable 20-nm class MLC SSD for Compute Apps
  - Adaptive Error Correction technology is required to enable scaling to application reliability needs from Client SSD to Enterprise SSD

Conventional Error Correction:
Stores ECC in spare field

Adaptive Error Correction:
Stores ECC in spare field and uses some of the NAND page
Reliability – Cluster Failure Mitigation

- Scaling causes increasing probability of infant mortality, word-line, bit-line and other cluster failures in addition to retention failures
- NAND DPPM rates may exceed several thousand DPPM requiring compensation/mitigation to meet acceptable SSD AFR specs
- Some of the failures may be captured through NAND component and SSD level testing at the expense of increased test cost/time
- Compensating cluster failures in addition to ECC is required to achieve highest reliability for SSDs used in Compute Apps

“RAID on Silicon” will evolve from a nice to have to a must have!
NAND flash physics sensitive to e.g. location, temp, time and disturb must be compensated!

§ Read Compensation

1. Soft Information during Read will be required to maximize endurance life for e.g. Enterprise SSD

§ Write Compensation

• Soft Information used to adjust NAND writes will be required to adjust for physical cell location

1. Disturb Compensation

• Multi-dimensional scrambling is required to avoid disturb effects in NAND flash during writes
Evolving NAND business model

- Increased complexity managing RAW NAND
- Proprietary soft-interfaces for NAND emerging
- NAND with ECC introduced, ClearNAND et. al.
  - Provides reliability at component level
  - Easier system integration and migration
- Question: What functionality is best served where?
  - Technical and business considerations impact decisions
- New NAND industry standards are needed to address diverging Consumer and Compute NAND needs

Needa soft-interface NAND standard for optimal deployment of future NAND in SSD
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*Random 4K transfers