How LDPC Enables New NAND Flash for Enterprise SSDs

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PMC

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- New NAND Flash Memory
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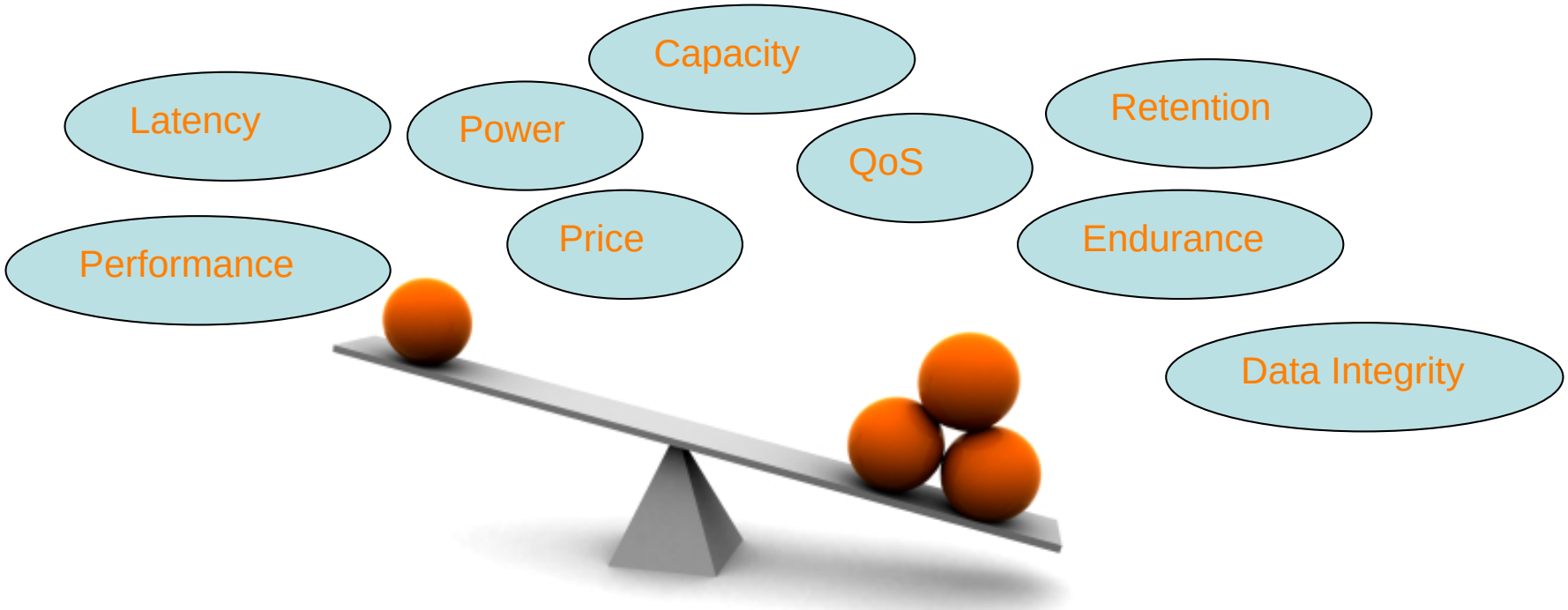
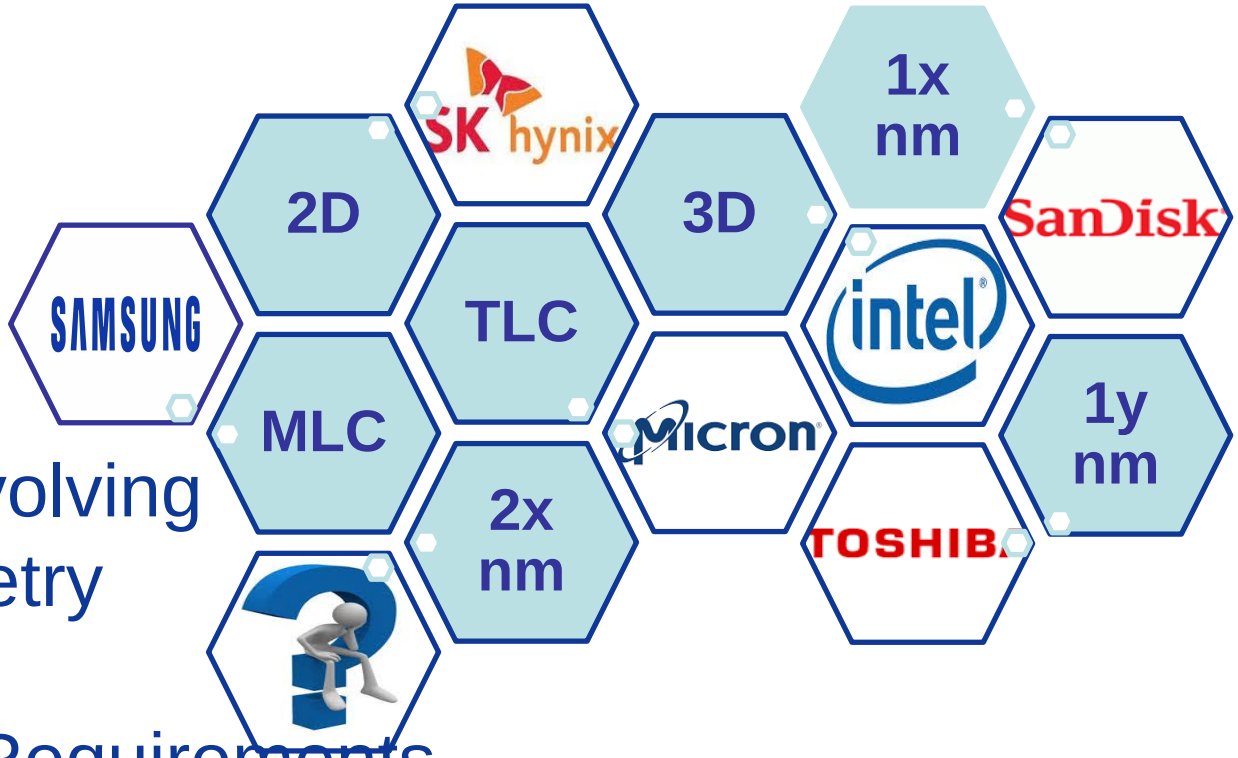
Enterprise SSD Requirements



Demanding list of requirements, makes it more challenging!

NAND Flash Proliferation

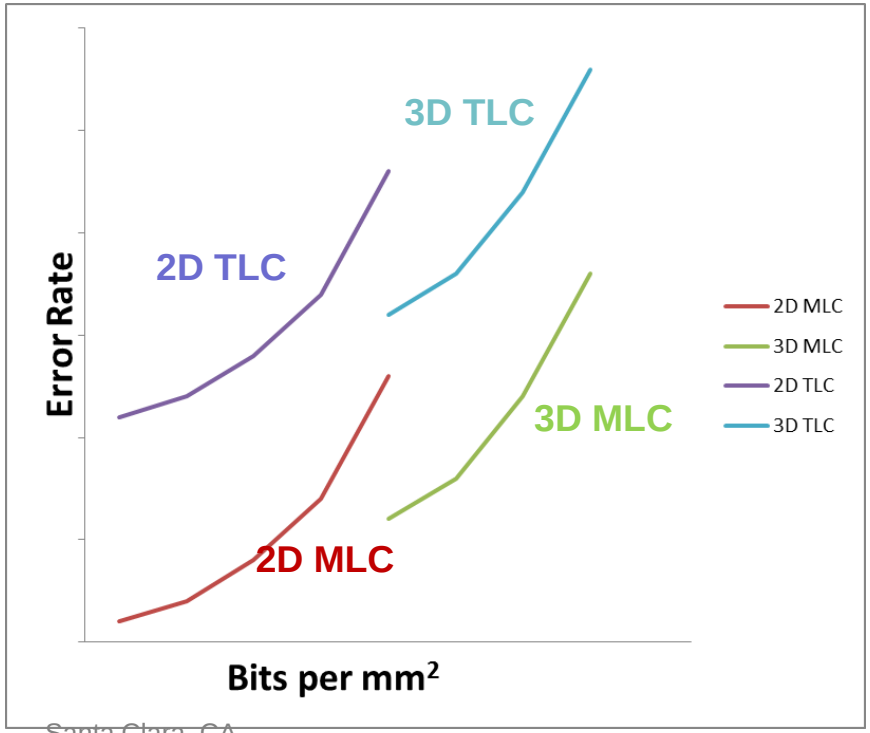


NAND Memories evolving

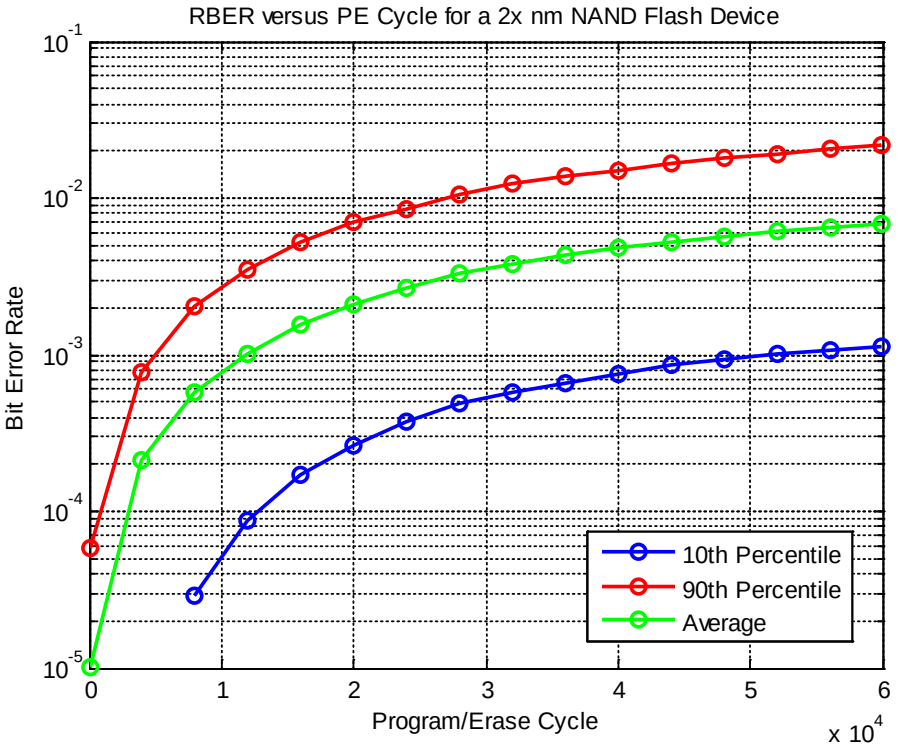
- Shrinking Geometry
- Scaling Capacity
- Increased ECC Requirements

New NAND Characteristics

Increased Error Rate

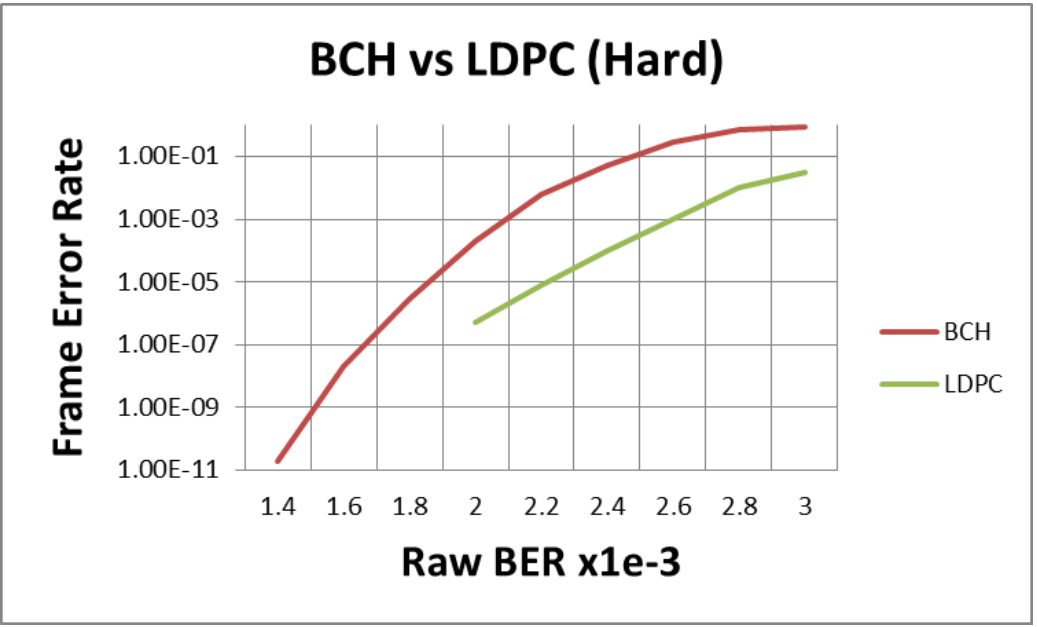


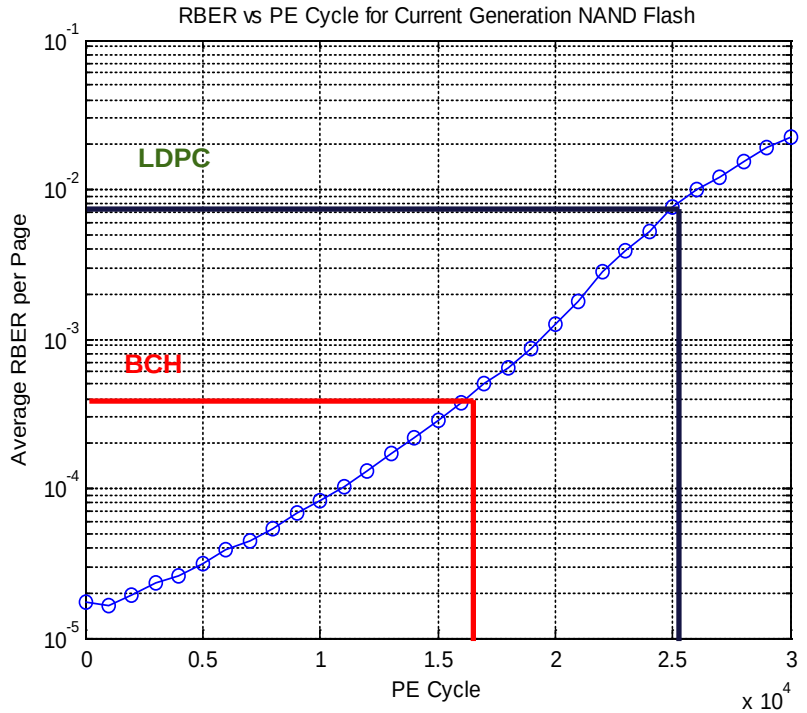
Decreased P/E Cycles



Contending ECC Algorithms

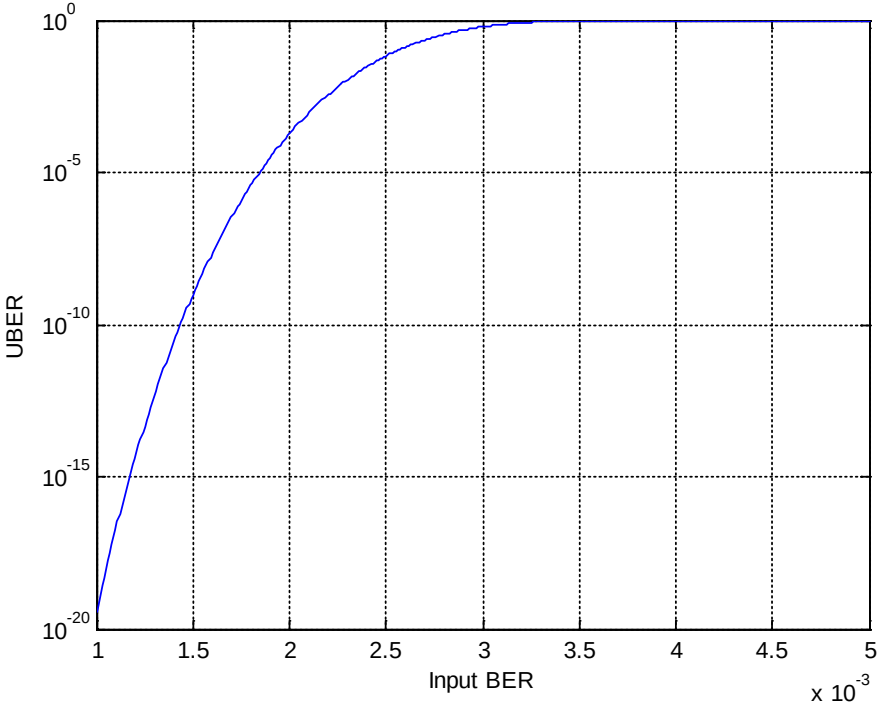
LDPC performs slightly better in Hard Decode, but it really shines more in Soft Decode





BCH False Decode Rate

- The BCH probability of false decode is bounded to 1/T![1]
- So for BCH:
- P(False) = P(Uncorrectable)/T!
- ~1e-176.
- So P(False) for BCH is astronomically low.

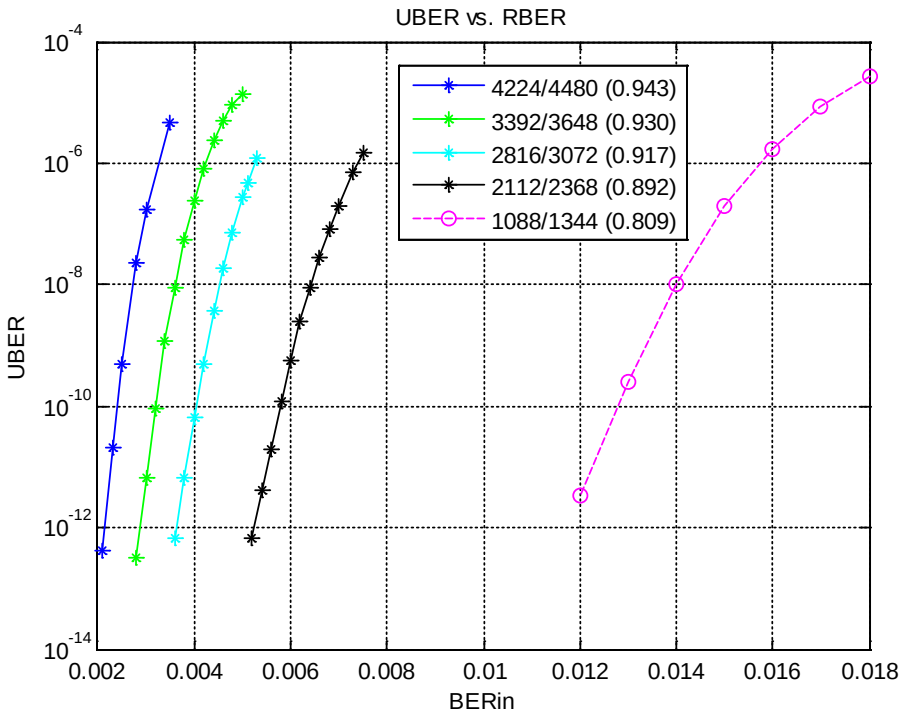


BCH codes can be mathematically proven to not have an error floor (distance spectrum).

[1]McEliece, R. and Laif Swanson. "On the decoder error probability for Reed-Solomon codes (Corresp.)." Information Theory, IEEE Transactions on 32.5 (1986): 701-703.

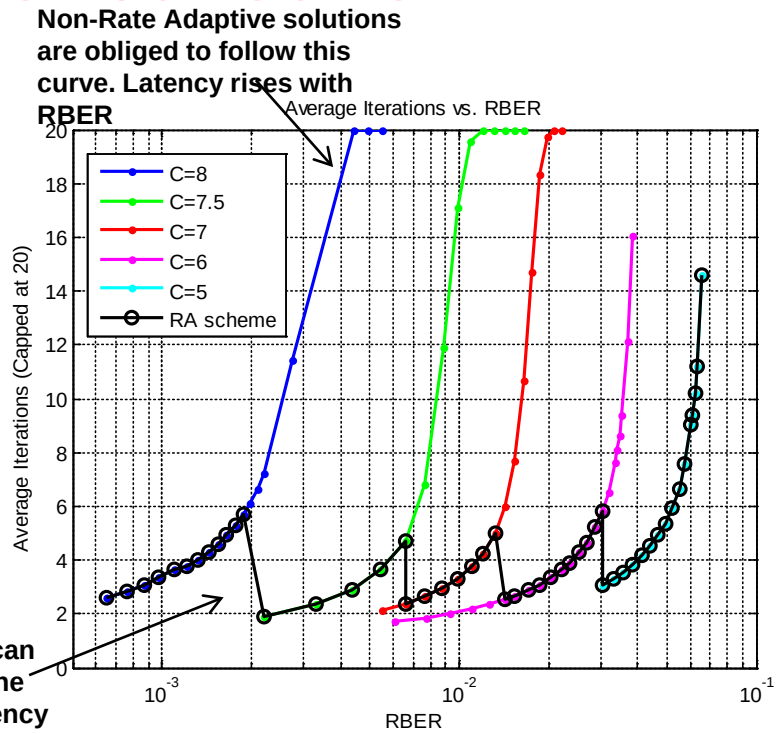
LDPC False Decode Rate

- Industry standard UBER is 1e-23 or better.
- LDPC has very strong ECC but does suffer from hard-to-predict error floors.
- With additional CRC protection, it can be extended further
- P(False) <= P(LDPC False)*P(CRC False).
- P(False) <= 1e-25.



Why LDPC is better suited for Enterprise SSDs

- Hard Decode & Soft Decode
- Adaptive Code Rate
- LDPC + CRC + RAID increases error tolerance
- Allow the software to perform intelligent operations



LDPC in a Software Defined Flash Controller is the key to the success!!

Summary

- Enterprise SSD requirements keep growing
- Next Generation NAND Flash Memory continue to evolve
- LDPC is better equipped to combat the challenges of new NAND types
- Combination of LDPC, CRC, RAID and Software is required to meet the Enterprise SSD needs

Q & A
Thanks!