



# Is 3D NAND a Disruptive Technology for Flash Storage?

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# Scaling Challenges for Planar NAND

- Planar NAND is hitting physical limits at about the 1z nm node: The cell size cannot be reduced much further.
- 3D NAND relaxes the cell dimensions and adds additional layers in the vertical direction.
- 3D NAND appears to be the only viable option to increase densities for the next 5-10 years until a better non-volatile mass storage technology emerges.

# Challenges of 3D NAND

- In principal, 3D NAND suffers from the same impairments as planar NAND:
  - Cell wear due to program/erase cycling, program disturb, read disturb, high and low temperature retention, cell-to-cell coupling.
  - The impact of some of these impairments is reduced compared to planar NAND due to the relaxed cell dimensions.
- In addition, 3D NAND suffers from:
  - Coupling in the vertical direction.
  - Yield challenges, since dozens of vertical layers are grouped together.

# 3D NAND Impact on Controllers

- How different is 3D NAND compared to planar NAND?
  - Cell-array architecture: Page, block and plane sizes and structure
  - Program and read algorithms
  - Error characteristics and ECC requirements
- What are the characteristics of cell-to-cell coupling?
- What are the yield characteristics?

# Need for LDPC-Enabled Controllers?

- NAND vendors can leverage the error correction power of LDPC-based ECC to:
  - Relax the physical dimensions and other cell parameters while maintaining the same or better endurance and reliability characteristics than planar NAND.
  - Achieve the required endurance and reliability targets for high-capacity (TLC) and high-endurance applications.
- As flash vendors increase 3D NAND densities by adding more vertical layers, increasing the number of levels per cell (TLC) and shrinking physical cell sizes, the need for LDPC-enabled controllers will increase further.

# Is 3D NAND a Disruptive Technology?

- Yes for the flash storage industry:
  - 3D NAND required the development of new cell-array architectures and requires significant investments in manufacturing.
  - 3D NAND opens up a new scaling path to increase capacities for the next 5-10 years.
- For the controller, it depends on:
  - The cell-array architecture, program and read algorithms, and error mechanisms of the 3D NAND device.
  - The flexibility of the controller architecture to deal with features of the 3D NAND device that are different from planar NAND.