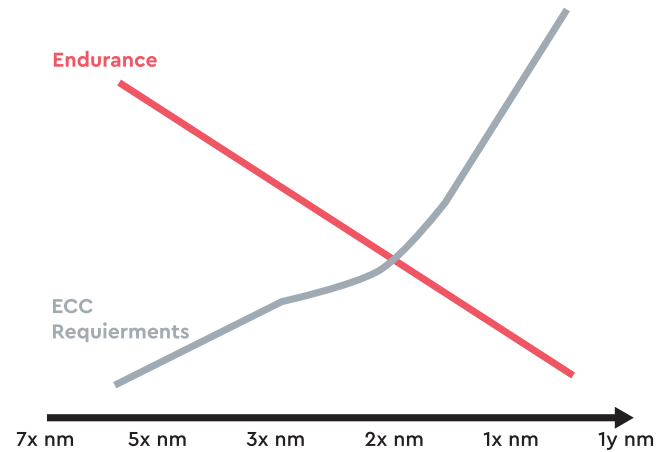# Guardian Technology™ Platform

Introduction

Due the industry's push to smaller lithography in the roadmap, the cost of NAND has continued to decrease. However, with each drop in the process node, endurance and reliability of the NAND flash decreases, going against the needs of enterprise environments where data reliability and integrity are critical.

Historically, the issue of endurance and reliability was addressed by adding Error Correcting Code (ECC) capability to the SSD controller. This approach is no longer sufficient as enterprise environments require higher endurance, predictable performance and reliability. To make SSDs viable in the data center, a new approach to overcoming NAND flash's inherent endurance and reliability limitations is required so that enterprise-grade SSDs can become both more cost-effective and meet enterprise application requirements.

Guardian Technology™ Platform

The Guardian Technology™ platform from Western Digital is a proprietary suite of enterprise features and endurance enhancement technologies designed to make the most cost-effective NAND flash enterprise-ready. Because of Western Digital's vertical integration and ownership of the flash, the Guardian Technology platform and NAND have been designed to work seamlessly with each other, taking full advantage of the endurance, performance and reliability enhancements the platform provides.

Western Digital's Guardian Technology platform is comprised of the following features:

- Enhanced endurance enabled by extracting significantly more usable life from MLC flash than provided by the standard specifications of the flash;

- End-to-end data path protection ensures that user data will be safe throughout the entire data path, and provides the ability to recover data from failed page and NAND blocks;

- Power-loss data protection enables enterprise-class reliability by preventing the loss and corruption of user data during unexpected power interruptions.

Enhanced Endurance

Leveraging two innovative technologies, Aggregated Flash Management and Advanced Signal Processing plus a mix of flash grades work together to extend the endurance of commercial grade MLC NAND flash to meet enterprise application endurance and reliability requirements.
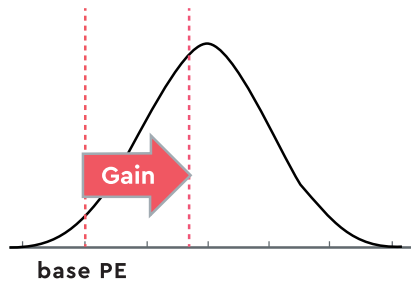
Aggregated Flash Management

- Utilizes average endurance of all die within the SSD
- SSD flash population endurance is greater than the sum of individual components
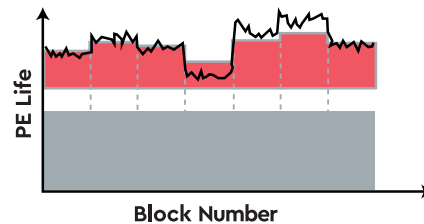
Advanced Signal Processing

- Provides adaptive programming of flash parameters throughout the life of the device
- Includes algorithms for adaptive programming developed based on extensive flash characterization
- Ensures each flash block is used to its maximum endurance capability
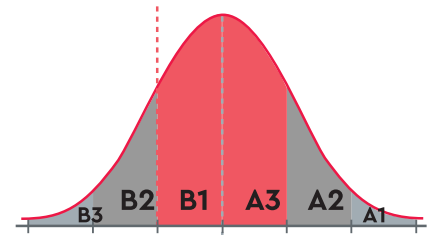
Intelligent Flash Mixing

- Takes advantage of fab data
- Provides intelligent mixing of "graded" die/wafer
- Ensures each drive has right mix of grades

End-to-end Data Path Protection

Full data path protection, safeguarding user data from corruption along all data paths in the SSD, such that Western Digital SSDs are specified to an UBER of 1 in 10^{17}, offering:
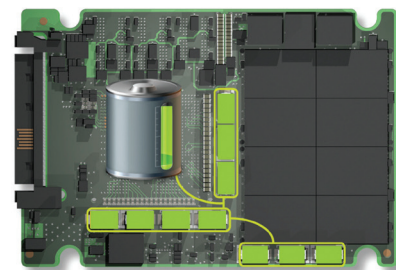
- T10-DIF (Data Integrity Field) for host control
- F.R.A.M.E. (Flexible Redundant Array of Independent Memory Elements)
  - Cross-die data redundancy
  - Data recovering on failed or blocked page
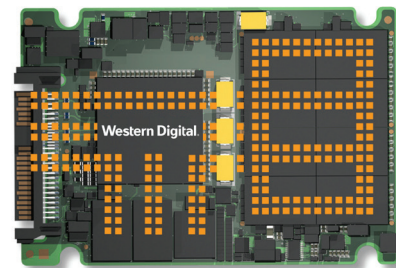
Power-loss Data Protection

Prevents against loss of user data in the event of unexpected power interruptions using a 3rd generation backup power circuitry design and high-reliability discrete capacitors.

- Protects data loss upon power failure
- Ensures no degradation over time
- Rated for high temperatures

Western Digital.