COMPREHENSIVE WEAR LEVELING MECHANISMS FOR SP INDUSTRIAL SD AND microSD CARDS

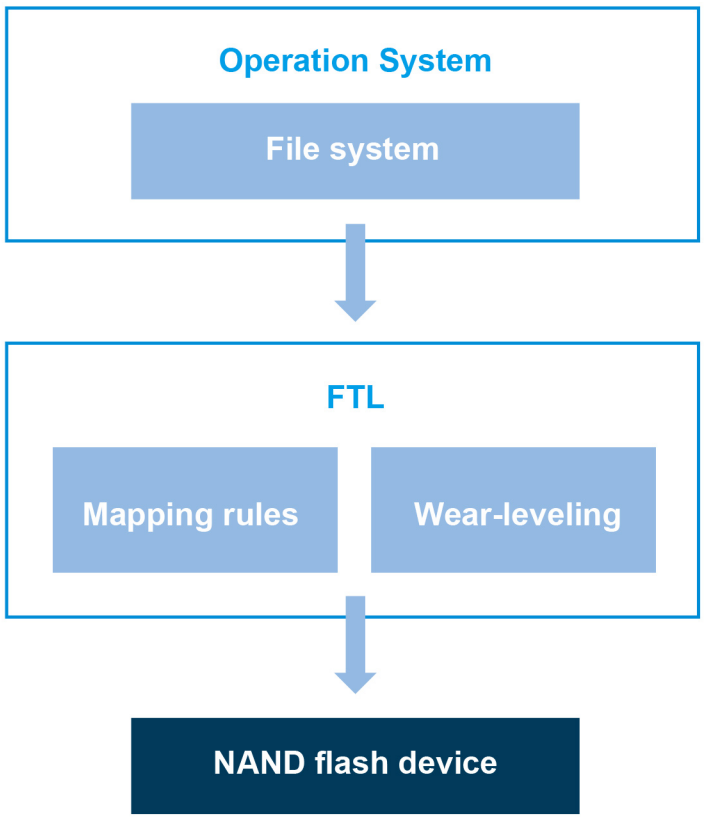
1. INTRODUCTION

For today's NAND flash devices, the main limitation is Program/Erase lifespan (number of P/E cycles). The key solution for this constraint is to manage the attrition rate in the entire NAND flash device so that each block will be evenly distributed. Therefore, efficient management of wear in whole blocks is required in order to maximize the lifespan of a NAND flash device. To accomplish this, one method is to manage the P/E cycle of each block individually, which will help to regularly distribute them and avoid overlaying on some blocks. This method is called wear leveling. There are two primary wear leveling mechanisms embedded in the flash translation layer (FTL) – static and dynamic.

2. FTL AND WEAR LEVELING

Wear leveling is implemented in the flash translation layer (FTL), which is the inter-medium mechanism between the file system and the NAND flash device. The FTL provides the mapping rules from logical to physical addressing. Wear leveling will help to reduce the wearing out of blocks over the mapping rules. As shown in Figure 1.

Figure 1 Wear Leveling in the FTL



3. FLASH BLOCK MANAGEMENT

The NAND flash device can be divided into three portions. The data block is reserved for logical capacity, the free block is assigned to wear leveling and bad block pool management, and the system block is assigned to the mapping table, cache block, etc. As shown in Figure 2.

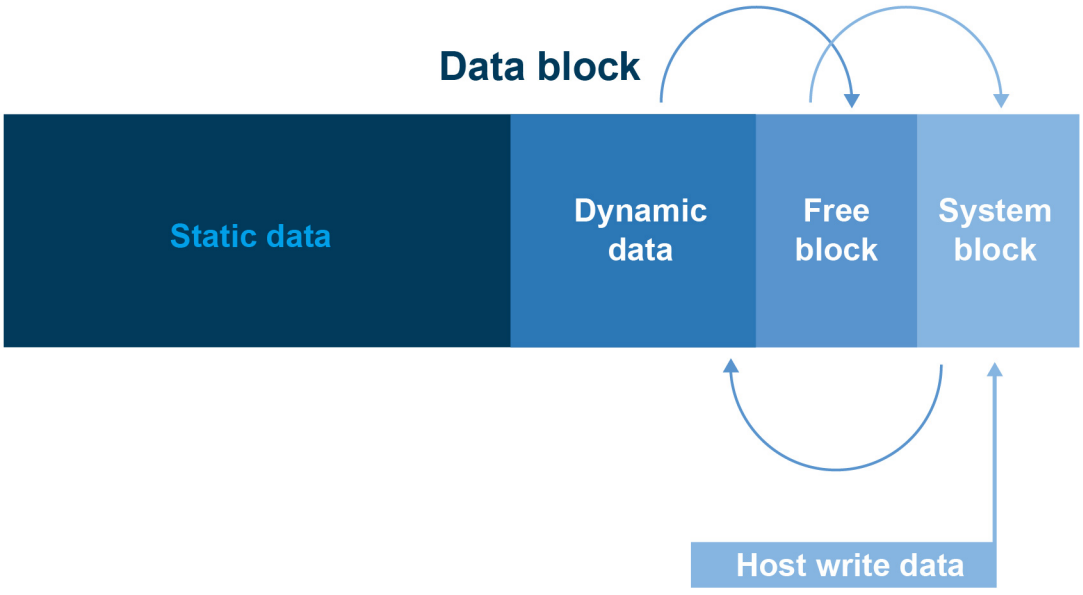
Figure 2 Flash Block Management

4. WEAR LEVELING

4-1 DYNAMIC WEAR LEVELING

There are two types of data subset in a NAND flash device: static data and dynamic data. Static data is information that is rarely used and seldom changed in physical blocks. On the other hand, dynamic data is frequently changing and constantly reprogramed. Dynamic wear leveling allocates dynamic data to the free blocks that have had the fewest P/E cycles. It is easier to implement this method, but in order to optimize the entire flash device completely, it is not a comprehensive technique. As shown in Figure 3.

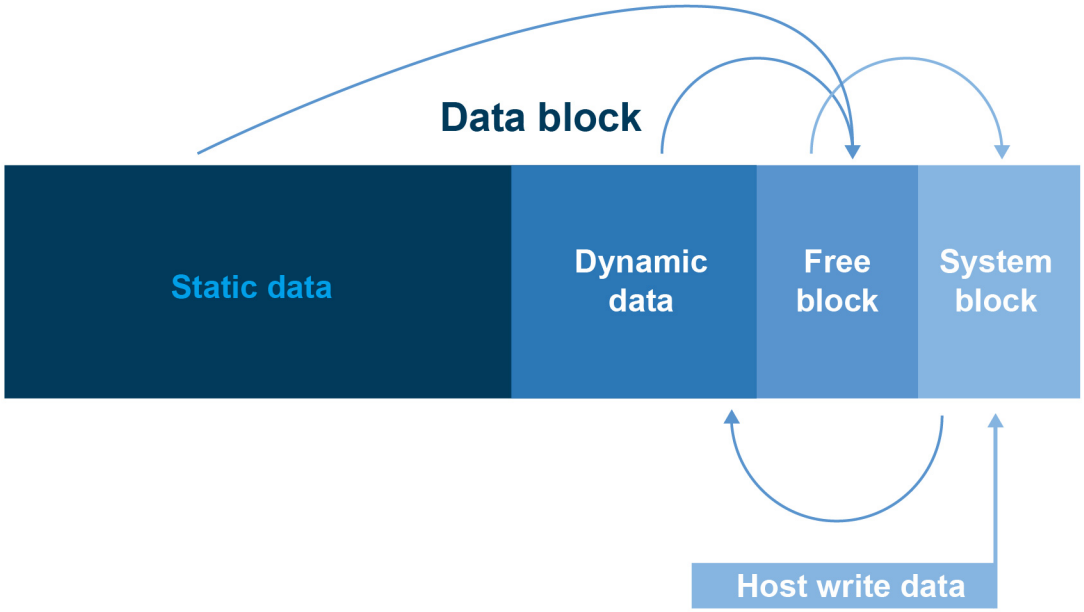
Figure 3 Dynamic Wear Leveling



4-2 STATIC WEAR LEVELING

Static wear leveling considers an entire NAND flash die, including blank areas and blocks to which have already been written. Static wear leveling allocates static data to the free block; as such, it enables liquidity of the flash device. It can amend the bottlenecking of overall wear leveling and get more efficient usage of memory array, therefore maximizing the lifespan of the flash device. As shown in Figure 4.

Figure 4 Static Wear Leveling



4-3 GLOBAL WEAR LEVELING

As opposed to static wear leveling, which only works on a single NAND flash die, the scope of global wear leveling covers the entire device. This ensures that write behavior occurs in blocks that are written to less frequently throughout the entire device. It achieves this balance by separating the flash device into several zones. If the host continues to access the same zone repeatedly, that zone is likely to wear out more quickly. Global wear leveling intervenes to prevent this from happening by re-allocating that access and ensuring an even level of wearing out. As shown in Figure 5.

Figure 5 Global Wear Leveling

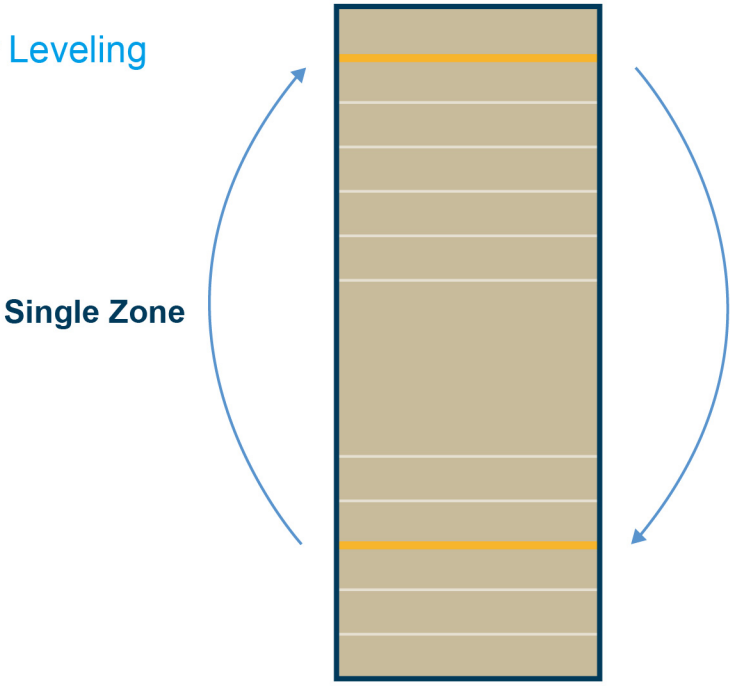
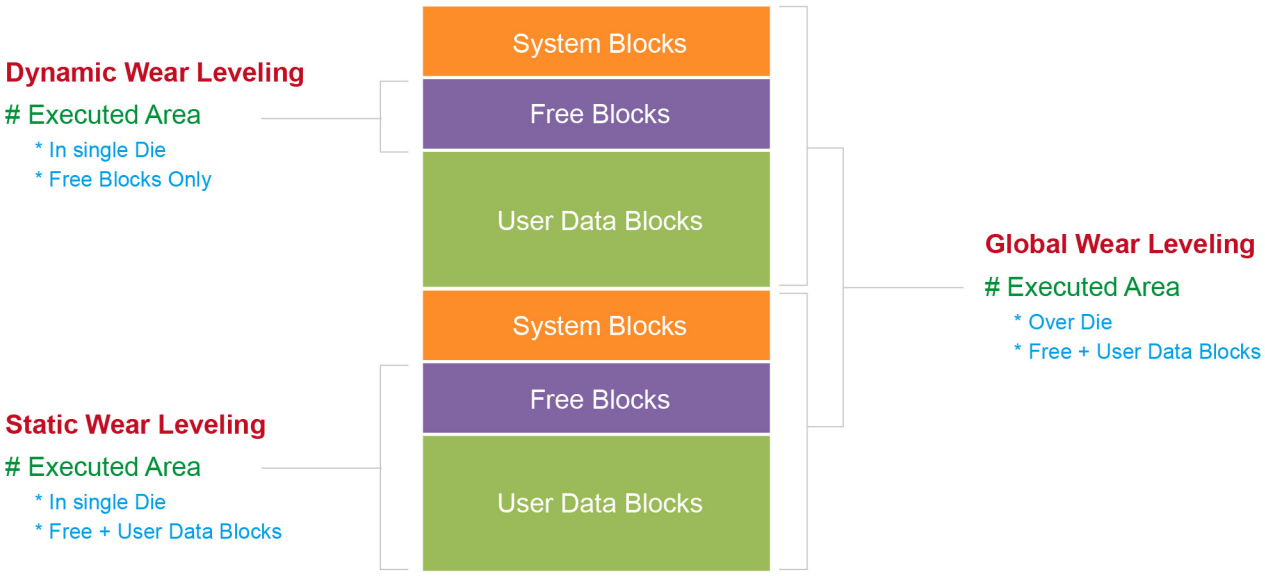


Figure 6 Comparison of Different Wear Leveling Mechanisms



5. SP INDUSTRIAL OFFERINGS FOR INDUSTRIAL SD AND MICROSD CARDS

SP Industrial's SD card series SDI730/530/330 and microSD card series SDT730/530/330 are comprehensively equipped with all of these mechanisms: global wear leveling, static wear leveling, and dynamic wear leveling. This multi-faceted coverage to manage all of the different statuses of flash usage achieves the best endurance and the highest reliability for optimized performance of the NAND flash.

SP Industrial's microSD card series SDT550/350 is equipped with static and dynamic wear leveling mechanisms. It offers the option for higher capacity with 3D TLC, but without the compromise of P/E cycle endurance.

These series are wildly adopted by critical applications, including dash camera surveillance video recording and Telematics systems for tier-1 automotive vendors, data log systems for Telecom 4G/5G base stations, and patient data recording for medical ventilator equipment in hospital ICUs.

* Information might be changed or updated without notice.