SSD Garbage Collection

White Paper

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Garbage Collection Function in SSD

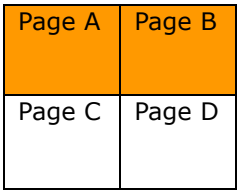
Overview

Most of the Solid State Drives (SSDs) currently available in the market incorporate Garbage Collection mechanism, a block-efficiency function used in NAND flash to deal with blocks with invalid, unused, or previously deleted data. Generally speaking, garbage collection is an SSD behavior that basically recognizes what's deemed as "garbage" in blocks, removes it and brings the good data to a new block.

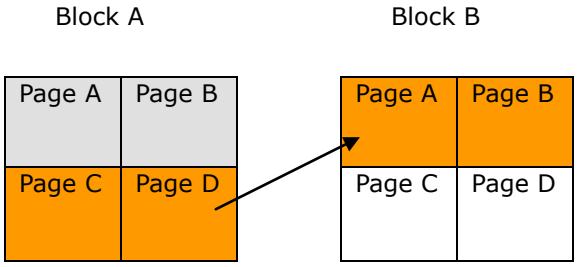
As time goes by, numerous cycles of data write and rewrite would eventually cause an SSD to have blocks with invalid or garbage data. For instance, some pages in a block may contain some previous deleted data. However, SSDs can not erase flash pages, only flash blocks instead. In fact, an SSD must erase the block before rewrite new data into it. If an average SSD storage cell can stand up to a specific number of write/rewrite cycles, Garbage Collection mechanism is highly important for the lifespan of it.

Flash works as the fundamental operation units for SSDs. Data in SSDs is written to flash pages, the basic memory units of blocks. However, when performing an erase, SSDs only deals with large units as blocks rather than pages. To go around with this problem, SSDs would detect and recognize the pages with unused, invalid data or garbage (also known as stale pages), then read and rewrite the pages with valid good data to another available block, while removing the old invalid data in the previously occupied block. This process is the Garbage Collection. Notably, SSDs would bring good data to another new empty block to avoid fast wear down of blocks, unless everywhere else is fully occupied. Though the effectiveness of Garbage Collection may vary among SSDs, some experts suggested that stronger cache and fast speed SSDs perform it better than others.

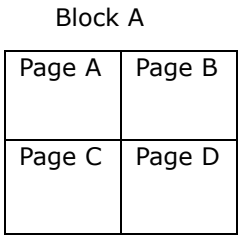
Normally, data can be written to pages of a block when vacant spaces are available. In this diagram, the host user writes data into Page A and Page B.



However, when data in Page A and B becomes old, invalid or garbage, meanwhile, the host user writes new data into Page C and D. Since SSDs can not just erase the pages, a whole block has to be erased before it can be rewritten or overwritten. Thus, data is read and written to a new block, said Block B.



On the other hand, Block A is erased. This process is known as Garbage Collection.



Background Garbage Collection

Since Garbage Collection requires read and write operations among blocks, it would obviously bring the performance down, especially when the SSDs are at work. Therefore, Background Garbage Collection has been introduced and it is also referred as the Idle Garbage Collection. This function is named in a straight-forward manner, as the process is performed by the controller when the device is in idle state or in the so-called “background” space. The controller takes the opportunity of idle times to go to the “back” and mark the location of invalid data and then cleans up. This would help SSDs to remain its high performance.

Different from TRIM

In short, TRIM informs the SSD controller to handle Garbage Collection by tracking LBAs (Logical Block Addresses) that are no longer valid or needed. However, TRIM is operating system dependent, which means this SATA command is available in certain OS, such as Windows 7 and newer Linux versions. In other words, some operating systems can not support TRIM, for instance, Windows XP and older versions of Mac OS.

Revision History

Revision	Date	Description	Remark
1.0	01/04/2016	Official release	

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