4K Page Mapping

White Paper

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Apacer
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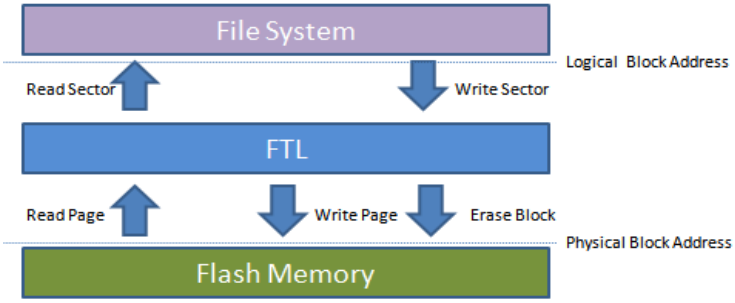
Introduction

As the architectural framework for the Internet of Things (IoT) gradually matures, portal websites, compact PCs, medical care and vehicular devices are expected to see rapid growth, becoming the focus of future development in the industrial automation market. From block mapping in the early days to hybrid mapping, the technology of mapping has continuously improved performance and lifespan but it is still unable to overcome the few extreme usage in industrial applications. To achieve a complete overhaul and comply with industrial applications, 4K page mapping has became a mainstream for SSD applications.

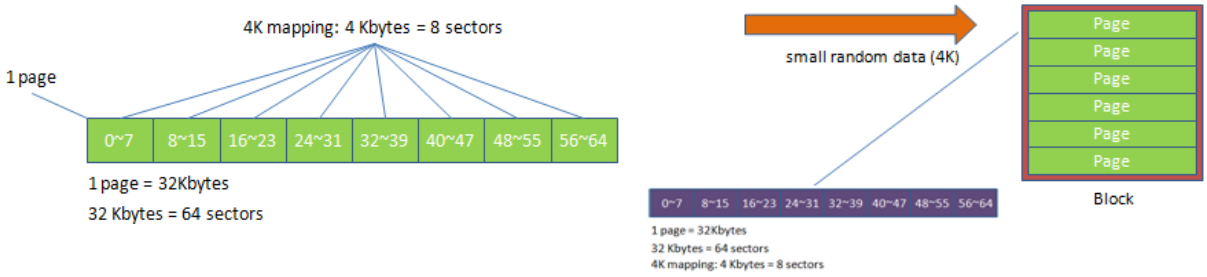
Flash translation layer



Flash Translation Layer (FTL) acts like a translator to perform communication between the sector-based file system and NAND flash chips. It is a software-based mechanism to support normal file systems with NAND flash memory. In order to increase its efficiency, it hides the complexity of flash and emulates flash as a hard disk drive by providing a logical block interface to the flash device. A FTL maps logical blocks to physical flash pages and erase physical blocks, called mapping table. It functions as a database query system allowing one to send an inquiry and retrieve the data from the database.

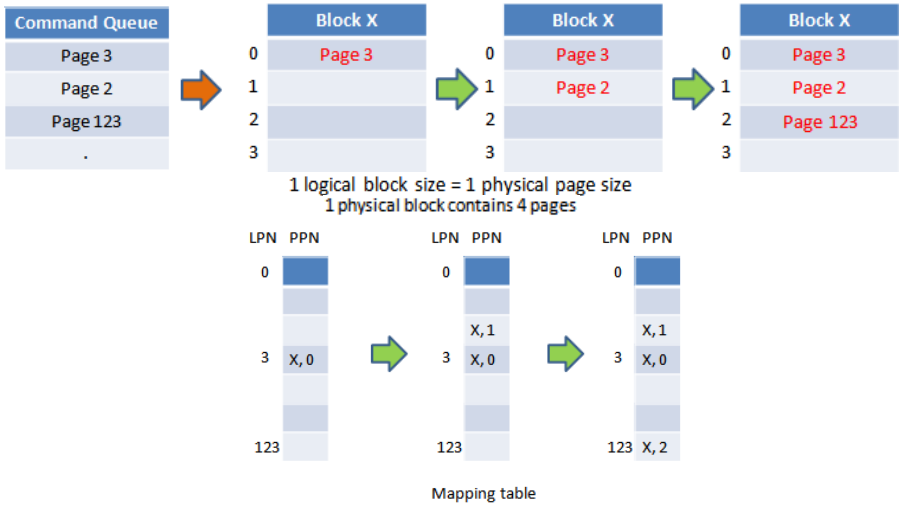
4K Page Mapping

4K page mapping has ability to gather data and automatically distributing data into each 4Kbytes section, and then scheduling them to be evenly written. For example, there is a page and its size is 32Kbytes, a page will be divided into 8 sections.



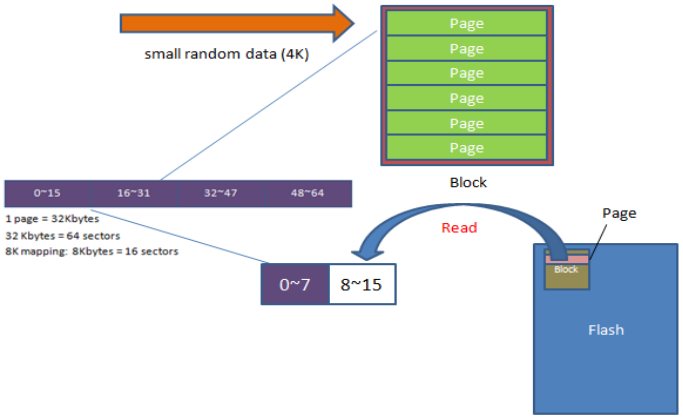
4K Page mapping uses one page as the unit of mapping. The most important characteristic of page mapping is that each logical page can be mapped to any physical page on the flash memory device. This mapping algorithm allows different size of data to be written to a block as if the data is written to a data pool and it does not need to take extra operations to process a write command. The below example shows how page-level mapping performs a write command:

Host instructs three write commands: page 3, 2, and 123. The three pages are written into block X in sequence of command queue. Once all write commands are completed, the mapping table updates itself automatically.



Note: the example only shows the concept of how page-level mapping work and do not necessary happen in an actual case

This fine-grained 4K page mapping scheme makes better capability for handling small random data, and increases overall performance and endurance significantly. However, 4K page mapping requires SSDs to incorporate a larger RAM in order to maintain its mapping table. Contrastively, if using 8K mapping in 4K based file system, each 8Kbytes section will not be full fill completely with it and FTL will find and read out a correspond offset in flash memory, then fill it into the rest of the section. This causes each 4K random data written into flash will have extra read behavior for data integrity.



Various effects on 4K page mapping & 8K page mapping structures

FTL Structure	4K Page Mapping	8K Page Mapping
Memory Requirement	Large	Normal
Random Write Performance	High	Normal
Endurance	Good	Normal

Revision History

Revision	Date	Description	Remark
0.1	03/16/2017	Preliminary	
1.0	03/16/2017	Official release	
1.1	03/29/2017	Add 4K mapping diagram and 8K mapping description	

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