Accommodating Solid State Storage in Your Favorite OS

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Agenda

- NAND data structure primer
- FTL overview
- SSD performance enablers
- Potential for improvement
NAND Data Structure Primer

- **Cache Register**: 4096 bytes + 218 bytes per block
- **Data Register**: 4096 bytes + 218 bytes per block

**Plane Details**:
- **1 page** = (4K + 218) bytes
- **1 block** = (4K + 218) bytes (x) 64 pages = (256K + 13K) bytes
- **1 plane** = (256K + 13K) bytes (x) 4096 blocks = 8810Mb
- **1 device** = 8810Mb (x) 2 planes = 17,620Mb (~ 17Gb)

**Block Layout**:
- **Plane of even numbered blocks** (0, 2, 4,...8188, 8190)
- **Plane of odd numbered blocks** (1, 3, 5,...8189, 8191)
Operating systems address disk-based storage by sectors.

The flash translation layer (FTL) “maps” the disk sectors that the operating system is designed to address.

FTL maps into physical location on the NAND array in the SSD.
SSD Performance Enablers

Controller

System interface

NAND parallelism delivers high system performance
SSD LBA to NAND Alignment

Firmware attempts to keep LBAs evenly split among all NAND devices for optimum performance.
PCMark in Windows Vista

Mobile Mark in Windows XP

Number of Access

Reads  Writes

512  1K  2K  4K  8K  16K  32K  64K  128K

512  1K  2K  4K  8K  16K  32K  64K  128K

Reads  Writes
Linux

Linux Installation

Linux File Write

Number of Access

Reads  Writes

512  1K  2K  4K  8K  16K  32K  64K  128K

512  1K  2K  4K  8K  16K  32K  64K  128K

Reads  Writes
Potential for Improvement

- Optimize sector size
- Trim
- Defragmentation
- Tagging hot data
Optimize Sector Size

- Ideal minimum transfer size = NAND page size
- 2X NAND page size for dual-plane operation
- Today NAND page size = 4KB
- Future NAND page size = 8KB
What is Trim?

- Trim is a newly defined command that provides a mechanism for the operating system to provide information to the SSD about LBAs that are no longer in use.
- Used properly, it has the potential to improve SSD performance in client platforms.
Without Trim

Operating System Content

SSD Content
Using Trim

Operating System Content

SSD Content
Defragmentation

- Like an HDD, SSDs can also benefit from files being defragmented and sequential in nature.
- Difference is the frequency of performing the defragmentation and the performance impact.
- Must be coupled with use of trim.
Tagging Hot Data

- If data is known to the drive to be active and changing often, it can be managed differently to improve drive performance and life
- Can be performed by the SSD firmware Adds processing cycles to SSD controller and FTL complexity
- OS could notify the SSD through a special command or metadata
- Reduces SSD controller processing load and FTL complexity