Working with cheap flash drives

Arnd Bergmann
Performance footprint of an SD card

Measurements from an extrememory hyperperformance Class 10 SDHC card, 8 GB, using Linux-2.6.37 with sdbi-pci driver.
Working with cheap flash drives

Read performance scatter graph

Partition data  FAT  Closed segment  Open segment  Closed segment  Closed segment  Erased segment  Erased segment

Read access time for 32 KB in ms

Position on the drive in MB
Static wear leveling over erase blocks

Writing to a free segment
Static wear leveling over erase blocks
Static wear leveling over erase blocks

Writing to a free segment
Static wear leveling over erase blocks

Writing to a free segment
Static wear leveling over erase blocks
Static wear leveling over erase blocks
Static wear leveling over erase blocks

Writing to a free segment
Static wear leveling over erase blocks

Overwriting a used logical segment
Static wear leveling over erase blocks

Overwriting a used logical segment
Static wear leveling over erase blocks

Overwriting a used logical segment
Static wear leveling over erase blocks

Overwriting a used logical segment
Static wear leveling over erase blocks
Static wear leveling over erase blocks

Logical segments

Physical segments

Writing to multiple segments
Static wear leveling over erase blocks

Writing to multiple segments
Static wear leveling over erase blocks

Writing to multiple segments
Static wear leveling over erase blocks

Writing to multiple segments
Static wear leveling over erase blocks
Static wear leveling over erase blocks
Static wear leveling over erase blocks
Static wear leveling over erase blocks
Static wear leveling over erase blocks
Static wear leveling over erase blocks

Concurrent FAT updates
Static wear leveling over erase blocks

Logical segments:
- FAT
- Erase
- Free list
- Bad

Physical segments:
- Erasing a segment
Static wear leveling over erase blocks

![Diagram showing the process of static wear leveling over erase blocks.](image-url)
Static wear leveling over erase blocks
Static wear leveling over erase blocks

Erasing a segment
Static wear leveling over erase blocks
Linear access optimized garbage collection
Linear access optimized garbage collection
Linear access optimized garbage collection
Linear access optimized garbage collection
Linear access optimized garbage collection
Linear access optimized garbage collection
Linear access optimized garbage collection
Linear access optimized garbage collection

Diagram showing logical and physical segments with optimized garbage collection.
Linear access optimized garbage collection
Linear access optimized garbage collection
Linear access optimized garbage collection
Linear access optimized garbage collection

Diagram showing the relationship between logical and physical segments in a flash drive.
Linear access optimized garbage collection
Linear access optimized garbage collection
Linear access optimized garbage collection
Linear access optimized garbage collection
Linear access optimized garbage collection

Logical Segment

Old Physical Segment

New Physical Segment
Linear access optimized garbage collection

Logical Segment

Old Physical Segment

New Physical Segment
Linear access optimized garbage collection

Logical Segment

Old Physical Segment

New Physical Segment
Linear access optimized garbage collection
Linear access optimized garbage collection

Logical Segment

Old Physical Segment

New Physical Segment
Linear access optimized garbage collection
Linear access optimized garbage collection

[Diagram showing logical segment, old physical segment, and new physical segment with optimization process]
Linear access optimized garbage collection
Linear access optimized garbage collection
Linear access optimized garbage collection
Linear access optimized garbage collection

Logical Segment

Old Physical Segment

New Physical Segment
Linear access optimized garbage collection
Linear access optimized garbage collection
Garbage collection with block remapping
Garbage collection with block remapping
Garbage collection with block remapping
Garbage collection with block remapping

Logical Segment

Old Physical Segment

New Physical Segment
Garbage collection with block remapping
Garbage collection with block remapping

Logical Segment

Old Physical Segment

New Physical Segment
Garbage collection with block remapping
Garbage collection with block remapping
Garbage collection with block remapping
Garbage collection with block remapping
Garbage collection with block remapping
Garbage collection with block remapping
Garbage collection with block remapping

Logical Segment

Old Physical Segment

New Physical Segment
Garbage collection with block remapping
Garbage collection with block remapping
Garbage collection with block remapping
Garbage collection with block remapping
Garbage collection with block remapping

Logical Segment

Old Physical Segment

New Physical Segment
Garbage collection with block remapping
Garbage collection with block remapping
Data logging garbage collection

Logical Segment

Old Physical Segment

New Physical Segment
Data logging garbage collection
Data logging garbage collection

Logical Segment

Old Physical Segment

New Physical Segment
Data logging garbage collection
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Data logging garbage collection
Running out of open erase blocks

Diagram showing the relationship between logical segments, physical segments, FAT, free list, and bad blocks. The diagram illustrates the process of writing without free segments.
Running out of open erase blocks

Writing without free segments: user writes to a logical segment that is not open
Running out of open erase blocks
Running out of open erase blocks

Writing without free segments: one segment is now unreferenced and can be erased
Running out of open erase blocks

Writing without free segments: one segment is now erased and can be reused
Running out of open erase blocks

Writing without free segments: start writing to the segment just freed up
Running out of open erase blocks

Writing without free segments: user writes to another logical segment
Running out of open erase blocks

Writing without free segments: free up a partial segment
Running out of open erase blocks

Writing without free segments: one segment is now unreferenced and can be erased
Running out of open erase blocks

Writing without free segments: one segment is now erased and can be reused
Running out of open erase blocks

Writing without free segments: start writing to the segment just freed up
Running out of open erase blocks

Writing without free segments: start writing to the segment just freed up
Running out of open erase blocks

Writing without free segments: user writes to another logical segment
Running out of open erase blocks

Writing without free segments: free up a partial segment
Running out of open erase blocks

Writing without free segments: one segment is now unreferenced and can be erased
Running out of open erase blocks

Writing without free segments: one segment is now erased and can be reused
Running out of open erase blocks

Writing without free segments: start writing to the segment just freed up
Running out of open erase blocks

Logical segments

Physical segments

Writing without free segments

FAT

Free list

Bad

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Running out of open erase blocks
Performance footprint of an SD card

Measurements from an extrememory hyperformance Class 10 SDHC card, 8 GB, using Linux-2.6.37 with sdhci-pci driver.
Flashbench demo
Planned optimizations

- Superpage buffer cache
Planned optimizations

- Superpage buffer cache
- Flashcache device mapper target
Planned optimizations

- Superpage buffer cache
- Flashcache device mapper target
- Erase block optimizations in elevator
Planned optimizations

- Superpage buffer cache
- Flashcache device mapper target
- Erase block optimizations in elevator
- File system block allocation
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