Betriebssysteme

11. Tutorium - Storage

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ITEC - Operating Systems Group

Device Management

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- Examples?

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- Applications typically deal with a file system on top of the device
- Examples? SSD, HDD, ...

Character Devices

- Provide a stream of characters
- Examples? Mice, Keyboard, (classic) text terminals

Communication with Devices

Port Based I/O

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Separate address space with dedicated instructions for reading/writing

- \+ Clear distinction in code $\Rightarrow$ Optimizing easier (reordering, caching, ...)
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Device registers are mapped into the physical address space. How do you access that?

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Memory-mapped I/O

Device registers are mapped into the physical address space. How do you access that? Normal instructions!

+ Higher flexibility: Virtual memory, larger instruction set, mostly transparent
- Some special rules apply to I/O regions software needs to be aware of

Similar Names - Compare DMA, memory-mapped I/O and memory-mapped files

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- OS abstraction: Treat a file like a normal range of virtual memory

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Memory Mapped Files

- OS abstraction: Treat a file like a normal range of virtual memory
- No real relation to DMA, though the OS might use it to synchronize Memory Mapped Files with the underlying device

I/O Operations

How does the OS know an I/O operation is finished?

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- Polling $\Rightarrow$ Periodically check device registers
- Interrupts $\Rightarrow$ I/O devices send an interrupt signal

Hard Disks

Hard Disk Layout

What parts can you find in a hard disk?

Hard Disk Layout

What parts can you find in a hard disk?

- Heads

Hard Disk Layout

What parts can you find in a hard disk?

- Heads
- Arms

Hard Disk Layout

What parts can you find in a hard disk?

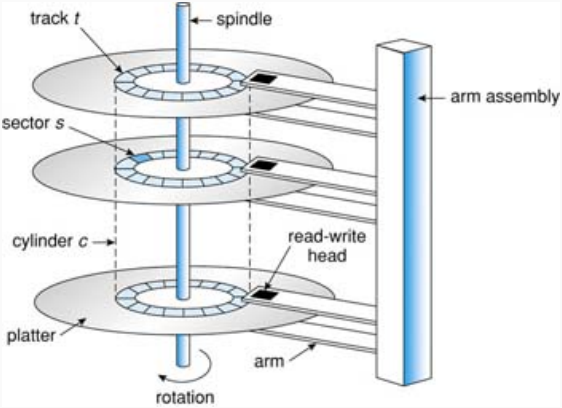
- Heads
- Arms
- Platters

Hard Disk Layout

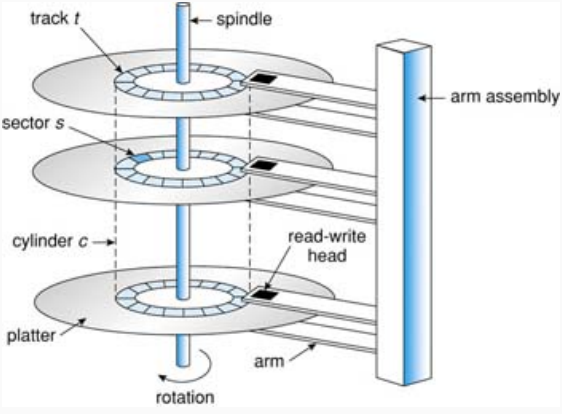
What parts can you find in a hard disk?

- Heads
- Arms
- Platters
- Spindle

Hard Disk Layout

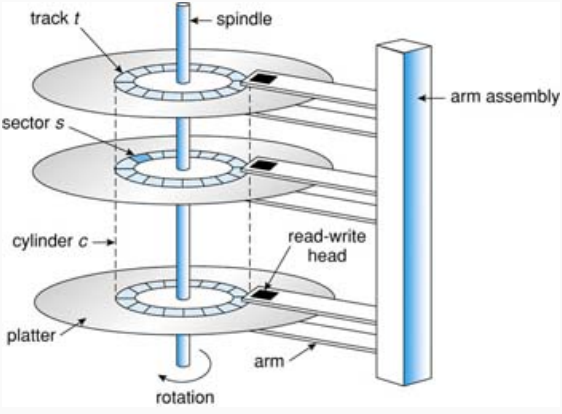


Hard Disk Layout



What do they do?

Hard Disk Layout



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- Spindle: Spin connected platters!

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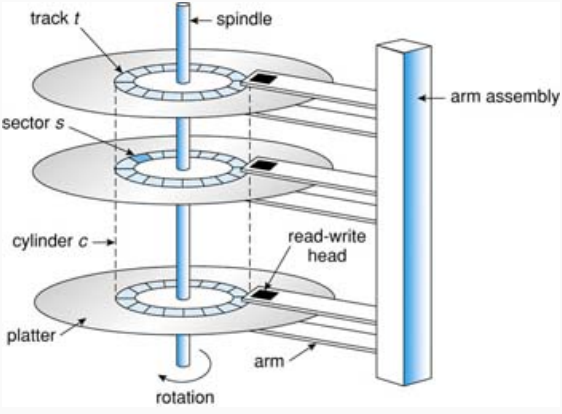

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- Head: Read/Write

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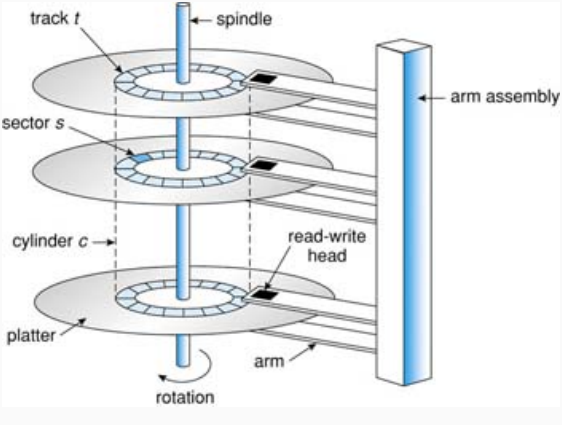
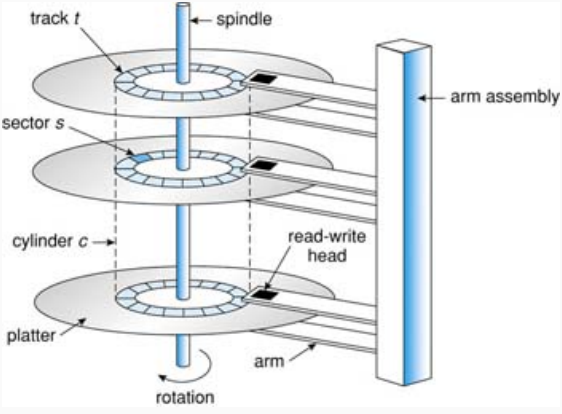


What do they do?

- Spindle: Spin connected platters!
- Head: Read/Write
- Arm: Move heads

Hard Disk Layout



How can you address data (512 byte blocks typically) on the disk?

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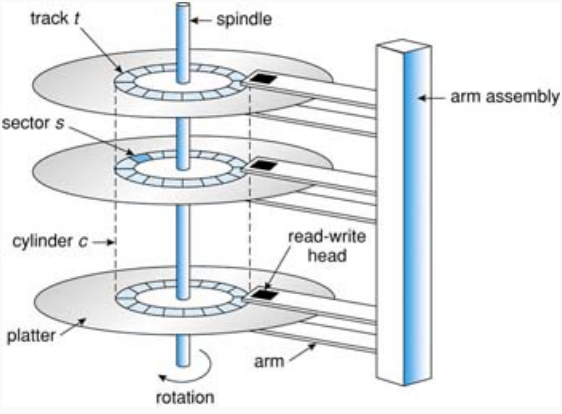

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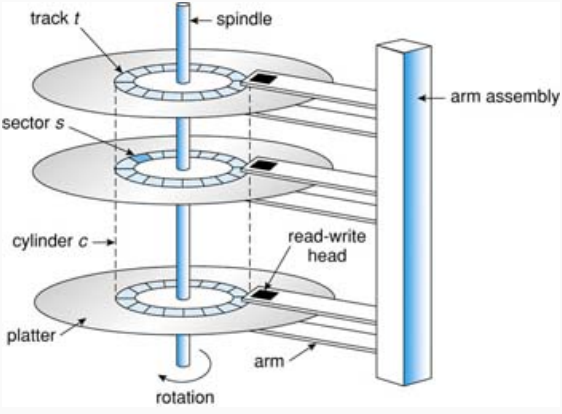

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- Logical Block Addressing (LBA). Each data block has its own unique number.

How could you optimize the OS $\Leftrightarrow$ Disk interface?

Native-Command-Queuing. OS sends reads and writes in batches and (the disk | the OS) reorders them based on internal geometry.

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Wear and Tear

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Disk marks it as such and never uses it again ⇒ *Sector sparing*.

What adverse effect might this have?

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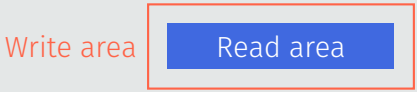
Disk marks it as such and never uses it again $\Rightarrow$ *Sector sparing*.
What adverse effect might this have? OS disk scheduler is unaware and optimizes for wrong geometry.

Hard Disk Layout - More Data!

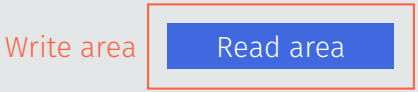
Optimizing storage



What can you do with this?

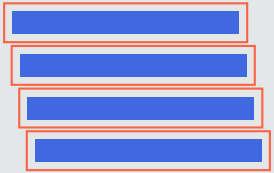
Hard Disk Layout - More Data!

Optimizing storage



What can you do with this?

Conventional layout



Hard Disk Layout - More Data!

Shingled Magnet Recording

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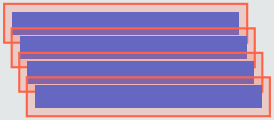

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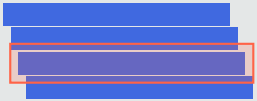

What happens when you write to this track?

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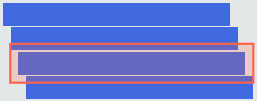

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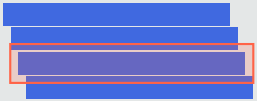

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⇒ Append only and group shingled tracks

⇒ Can rewrite the whole group at once

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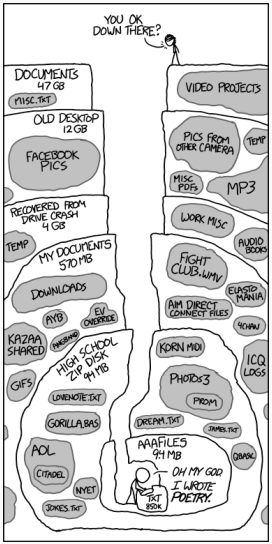
  $\Rightarrow$ *Host Managed*
- Compromise. Tell the OS where your singled zones are and expose their tail. If the OS writes to the tail, directly commit it - else buffer.
  $\Rightarrow$ *Host Aware*

Ende



XKCD 1360 - Old Files

F R A G E N?

https://forms.gle/9CwJSKidKibubran9

Bis nächste Woche