

COSC 511: Computer Architecture

Data Storage

Week 9

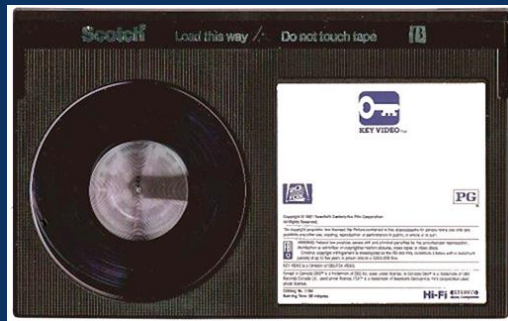
Two Weeks Ago

- The Processor (Part 3)
 - Floating Point Units
 - More details about amd64 Processors
 - Components of a Computer
 - Types of Memory
 - SIMM vs DIMM Memory
 - I/O Systems
 - Various levels of I/O communication.
 - Tradeoff between low-level control and portability across platforms.

Last Week

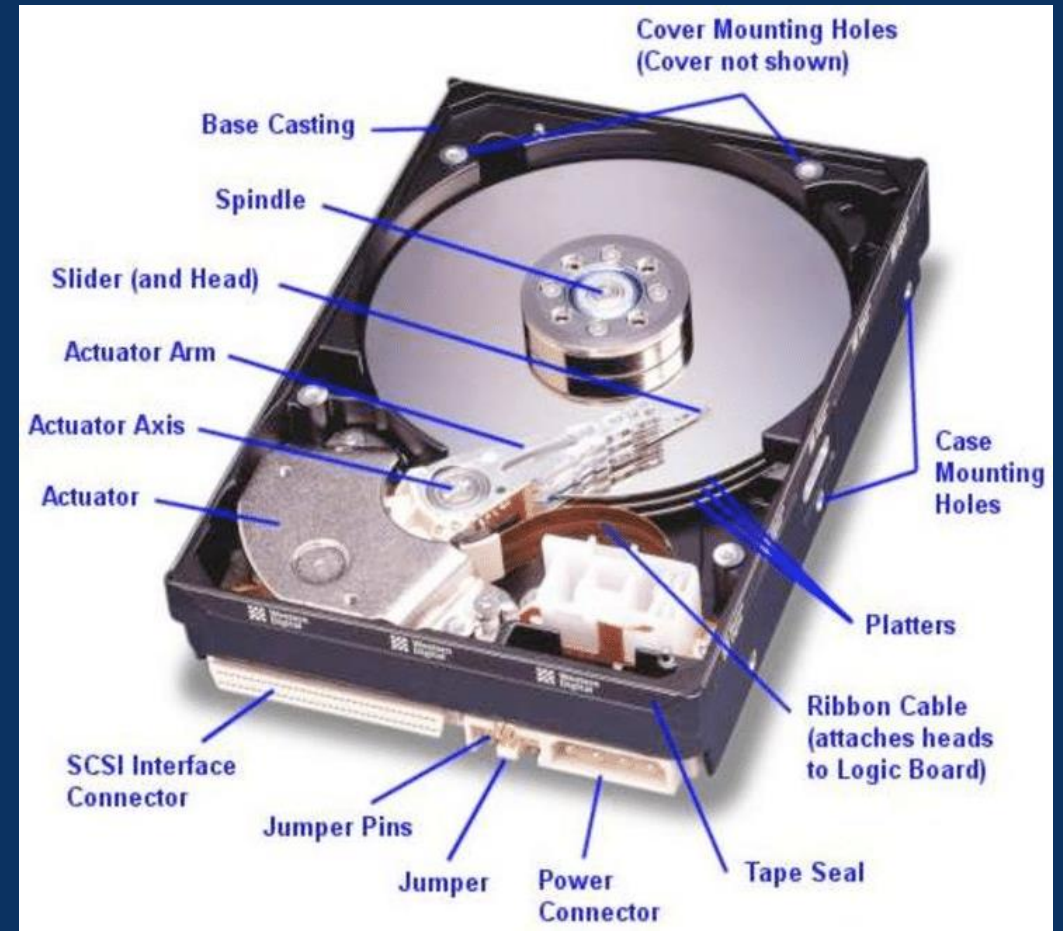
Midterm

Data Storage



Components of a Traditional Hard Drive

- The limiting factor to hard drive speed is the mechanical components.
 - The platters rotate just like an optical disk.
 - The actuator arm moves the head back and forth across the surface of the platters to read and write data.
 - Seek Time
 - The time taken for a disk drive to locate the area on the disk where the data to be read is stored.

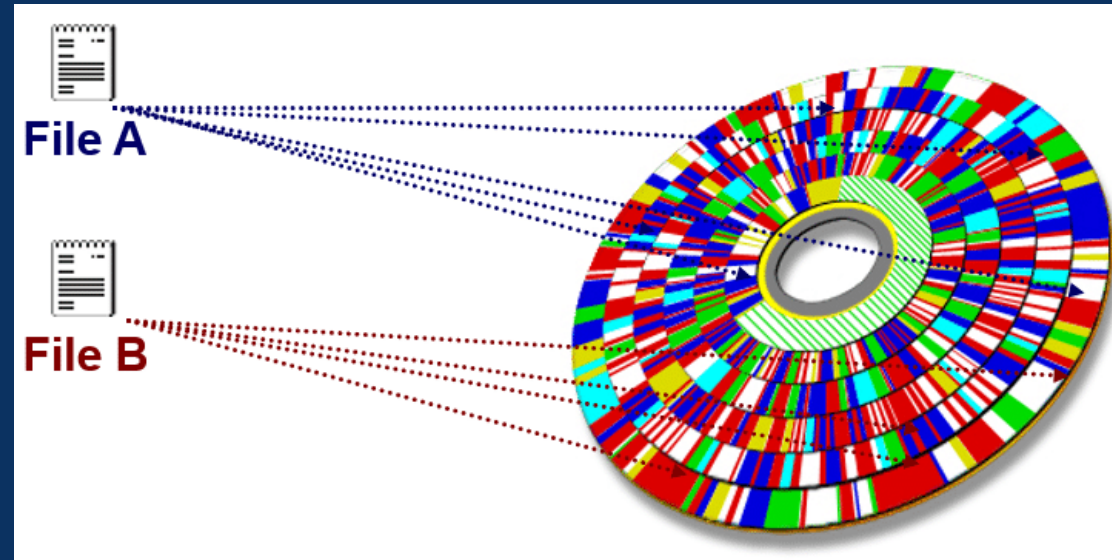


Hard Drives

- Platters are coated with a thin layer of magnetic coating.
- To write data, the head adjusts the magnetism of tiny sections on the platter.
 - If the north pole is facing the head, it represents a 1.
 - If the south pole is facing the head, it represents a 0.
- To read data, the head analyzes the sections and translates it back.
- Most of the delay in hard drive response comes from seek time.
 - This is why data fragmentation on hard drives is such a big deal.

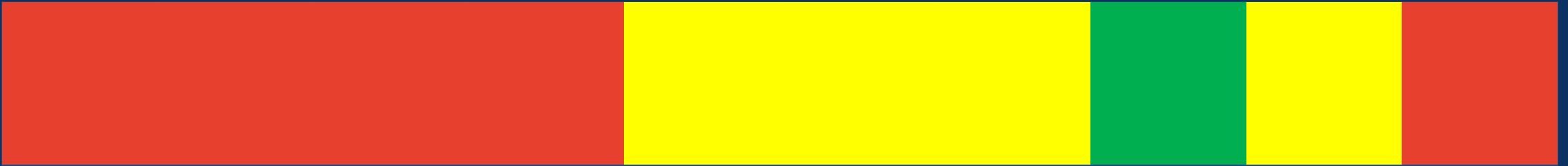
Hard Drives

- Data Fragmentation
 - Occurs when related data is stored in fragments scattered around the drive platters rather than contiguously.



Hard Drives

Why does data fragmentation occur?



Key:

White: Empty

Red: File 1

Yellow: File 2

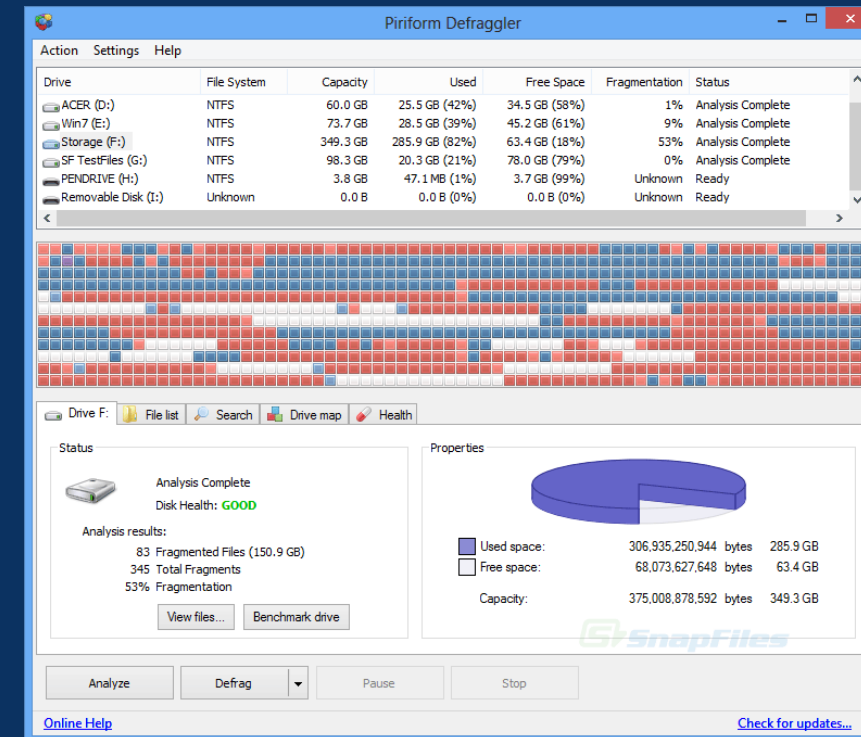
Green: File 3

Hard Drives

- Why does data fragmentation increase response time?
 - If data is stored contiguously, the start of the data can be found and then read in order.
 - In this scenario, the head only needs to do a small amount of moving.
 - If the data is fragmented across different parts of the platter, the head has to repeatedly seek to find where the next fragment of data is stored.
 - Remember: Hard drives have an average seek time of 9ms.
 - [Hard Drive Seek Demo](#)

Hard Drives

- How do we resolve fragmentation?
 - Never change anything about the files you store once you store them.
 - Occasionally defragment your hard drive.
 - Use a file system that uses heuristics to reduce the amount of fragmentation.
 - Almost every modern file system does this.
 - Old file systems did not.



Hard Drives

- Fragmentation is not the only problem.
- Other sources of hard drive latency:
 - Performing multiple read and/or write operations at the same time
 - Paging!
- For a long time, there was no true solution to fragmentation.
- There is a solution now, though!
 - Don't use hard drives to store your data.
- Use a Solid State Drive instead!

Hard Drives

- Why is paging to an SSD worse than paging to a hard drive?
 - You already know the answer to this. 😊
- Why is paging to a hard drive worse than paging to an SSD?
 - SSD seek times are much better than a hard drive.
 - Reminder:
 - Hard Drive Average Seek Time: 9ms
 - SSD Average Seek Time: 0.16ms
 - SSDs do not have a seek time penalty like hard drives do.
 - Fragmentation still happens on SSDs, but it does not matter.
 - You can still defragment an SSD if you want, but you shouldn't!
 - Why not? We'll talk about that next week.

Next Week

- Why shouldn't you defragment an SSD?
- How do SSDs store data?
- Pros and cons of SSDs
- How do flash drives, SD cards, etc. work?

- Other Stuff