OPERATING SYSTEMS

Storage Management

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Mass-Storage Structure

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Slides Credits for all PPTs of this course

- The slides/diagrams in this course are an **adaptation**, **combination**, and **enhancement** of material from the following resources and persons:

1. Slides of Operating System Concepts, Abraham Silberschatz, Peter Baer Galvin, Greg Gagne - 9th edition 2013 and some slides from 10th edition 2018
2. Some conceptual text and diagram from Operating Systems - Internals and Design Principles, William Stallings, 9th edition 2018
3. Some presentation transcripts from A. Frank – P. Weisberg
4. Some conceptual text from Operating Systems: Three Easy Pieces, Remzi Arpaci-Dusseau, Andrea Arpaci Dusseau

Overview of Mass Storage Structure

- **Magnetic disks** provide bulk of secondary storage of modern computers.
- Each disk platter has a flat circular shape, like a CD. Common platter diameters range from 1.8 to 3.5 inches.
- The two surfaces of a platter are covered with a magnetic material.
- The heads are attached to a disk arm that moves all the heads as a unit.
- The surface of a platter is logically divided into circular tracks, which are subdivided into sectors.
- The set of tracks that are at one arm position makes up a cylinder.

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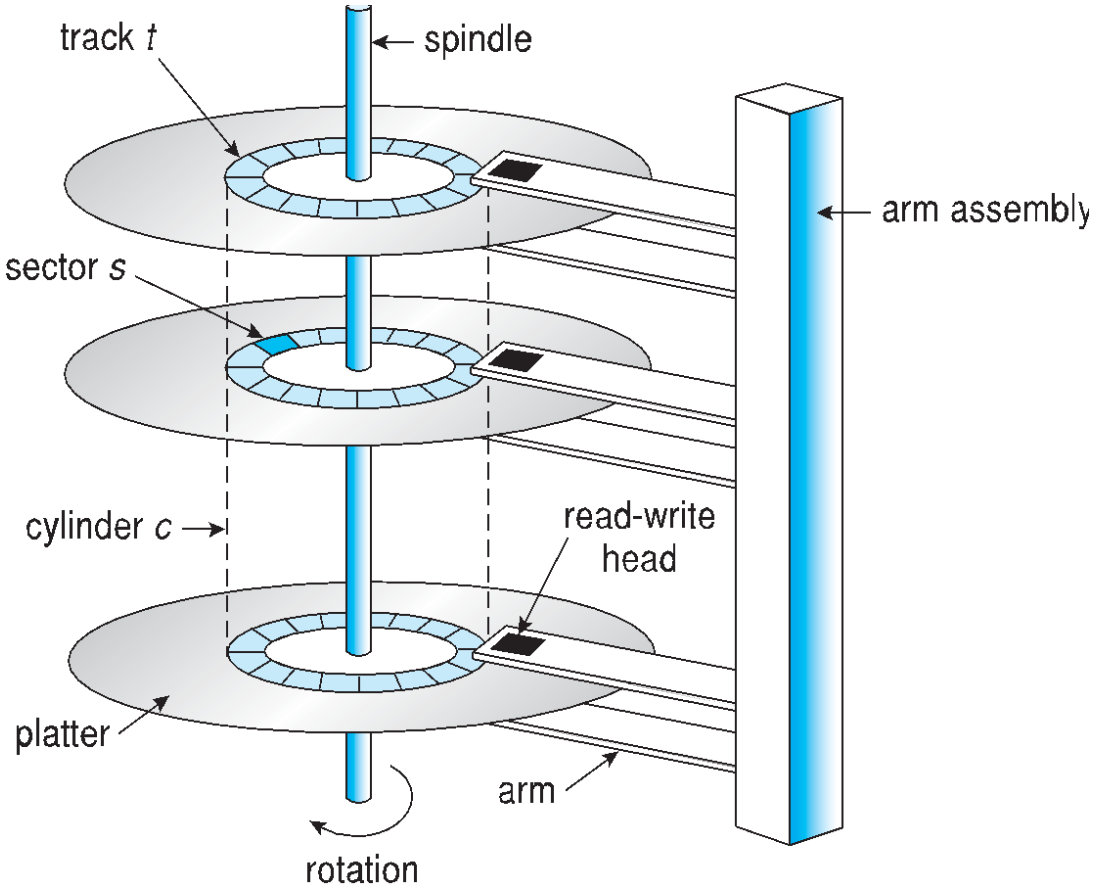
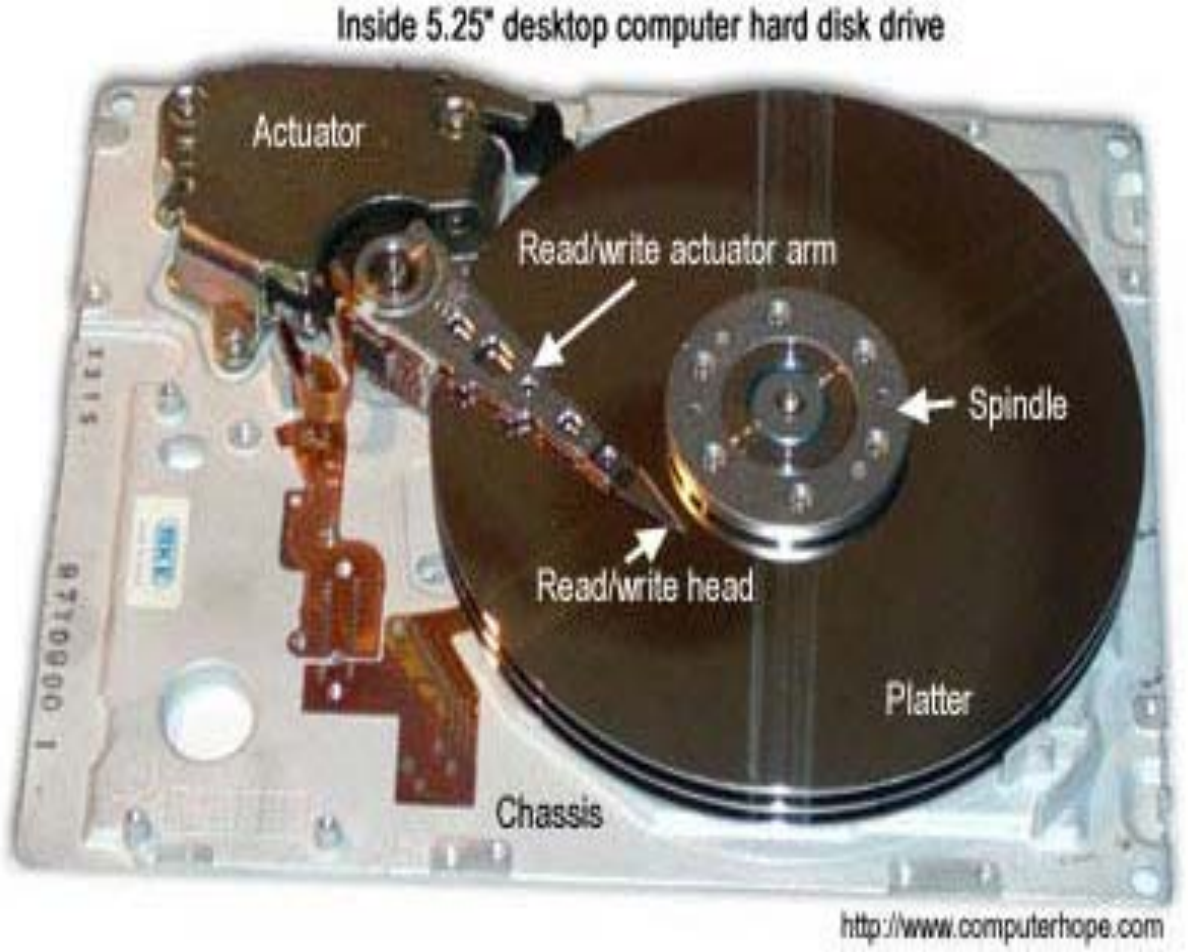
Moving-head Disk Mechanism





Overview of Mass Storage Structure

- When the disk is in use, a drive motor spins it at high speed. Most drives rotate 60 to 250 times per second.

Disk speed has two parts.

- The transfer rate is the rate at which data flow between the drive and the computer.
- The positioning time, or random-access time, consists of two parts
  - The time necessary to move the disk arm to the desired cylinder, called the **seek time**.
  - the time necessary for the desired sector to rotate to the disk head, called the **rotational latency**.

Disk Latency = Seek time + Rotational latency + Transfer time

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Magnetic Disk Specifications – Reference: www.seagate.com

Specifications	Barracuda®	Constellation®	Constellation ES	SV35 Series™
Primary Applications	Optimised for PC and personal external storage	Optimised for 2.5-inch business server and external storage arrays	Optimised for 3.5-inch business server and external storage arrays	Optimised for video surveillance applications
Capacity (GB)	250, 320, 500, 750, 1,000 1,500, 2,000, 3,000	250, 500, 1,000	500, 1,000, 2,000, 3,000	1,000, 2,000, 3,000
Spin Speed (RPM)	7,200	7,200	7,200	7,200
SATA interface (Gb/s)	1.5/3.0/6.0	1.5/3.0/6.0	1.5/3.0/6.0	1.5/3.0/6.0
SAS interface (Gb/s)	—	3.0/6.0	3.0/6.0	—
Rotational vibration (RV) (radians/s/s)	5.5 narrow spectrum up to 300Hz	16 broad spectrum up to 1,800Hz	12.5 broad spectrum up to 1,500Hz	5.5 narrow spectrum up to 300Hz
Seek time, average read/write (ms)	<8.5/<9.5	8.5/9.5	8.5/9.5	<8.5/<9.5
Cache (MB)[1]	16, 64	Up to 64	Up to 64	64
Non-recoverable read errors per bits read	1 sector per 10^{14}	1 sector per 10^{15}	1 sector per 10^{15}	1 sector per 10^{14}
Power-on hours (POH)	2,400 – 8x5	8,760 - 24x7	8,760 - 24x7	8,760- 24x7
Streaming capabilities	—	Multiple sequential streams	Multiple sequential streams	Up to 20 simultaneous HD streams[3]
POH usage profile	8x5 – On as needed	24x7 – Always on	24x7 – Always on	Up to 64 cameras 24x7 – Always on
MTBF (hours)	700,000	1.4 million	1.2 million	1 million
Power, average – idle (W)[2]	4.6	2.25 to 3.85	>3.74	—
Power, average – Idle2 (W)[2]	3.4 to 5.4	—	—	3.4 to 5.4
Acoustics, typical – idling (bels)	2.2 to 2.4	2.2	1.9 to 2.7	2.2 to 2.4
Shock, operating/non-operating (Gs)	70 to 80/300 to 350	70/400	40 to 70/300	80/300 to 350
Ambient temperature, operating/ non-operarting (°C)	0 to 60/–40 to 70	5 to 60/–40 to 70	5 to 60/–40 to 70	0 to 70/–40 to 70
RAID support	0, 1	0, 1, 3, 4, 5, 6, 10	0, 1, 3, 4, 5, 6, 10	0, 1, 3, 4, 5, 6, 10
RAID Rebuild™ support		•	•	
Enterprise expert support		•	•	•

Overview of Mass Storage Structure

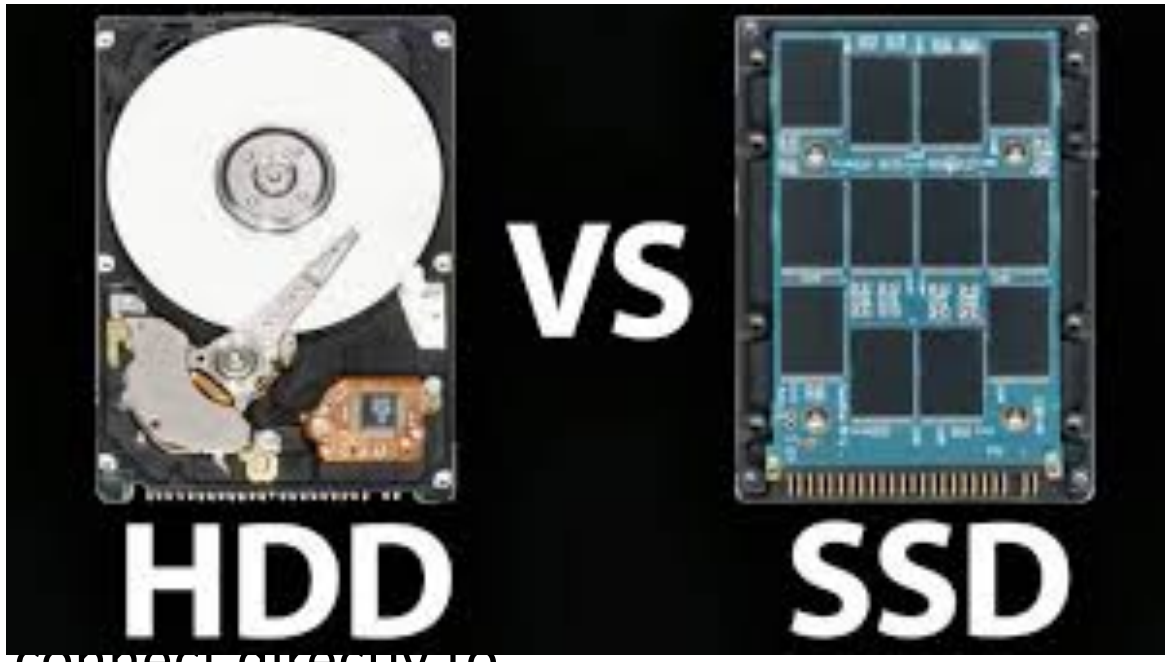
- Disk head flies on an extremely thin cushion of air.
- head will sometimes damage the magnetic surface when it makes contact with it.
  - Head crash
  - Not recoverable
- A disk can be **removable.**
- Removable magnetic disks generally consist of one platte
- Examples CDs, DVDs, and Blu-ray discs as well as removable flash-memory

Mass Storage Structure (Cont.)

- Drive attached to computer via **I/O bus**
  - Busses vary, including **EIDE**, **ATA**, **SATA**, **USB**, **Fiber Channel**, **SCSI, SAS, Firewire**
    - SCSI is a set of parallel interface standards developed by ANSI
    - allows more hard disks per computer compared to IDE
    - SCSI is harder to configure compared to SATA and IDE
    - EIDE has a 133 megabytes per second speed rate, while SATA has up to a 150 megabytes per second speed rate.
  - **Host controller** in computer uses bus to talk to **disk controller** built into drive or storage array

Solid-State Disks

- Nonvolatile memory used like a hard drive
  - Many technology variations
- Can be more reliable than HDDs
- More expensive per MB
- Maybe have shorter life span
- Less capacity
- But much faster
- Standard Bus interfaces can be too slow -> connect directly to the system bus (PCI, for example)
- No moving parts, so no seek time or rotational latency



Magnetic Tape

- Was early secondary-storage medium
  - Evolved from open spools to cartridges
- Relatively permanent and holds large quantities of data
- Access time slow
- Random access ~1000 times slower than disk
- Mainly used for backup, storage of infrequently-used data, transfer medium between systems

Magnetic Tape (Cont.)

- Kept in spool and wound or rewound past read-write head
- Moving to the correct spot on a tape can take minutes, but once positioned, tape drives can write data at speeds comparable to disk drives.
- Tape capacities vary greatly, depending on the particular kind of tape drive, with current capacities exceeding several terabytes.
- Some tapes have built-in compression that can more than double the effective storage.
- Tapes and their drivers are usually categorized by width, including 4, 8, and 19 millimeters and 1/4 and 1/2 inch.
- Some are named according to technology, such as LTO-5 and SDLT.

THANK YOU

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