

# Systems and Networking – Unit I

B.Sc. in Applied Computer Science and Artificial Intelligence  
2022-2023

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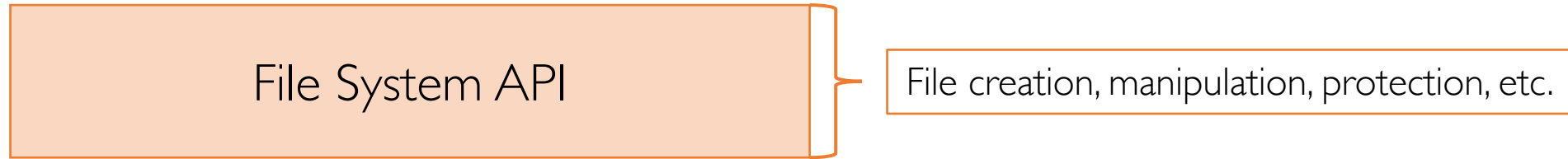
**SAPIENZA**  
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# File System's Logical View

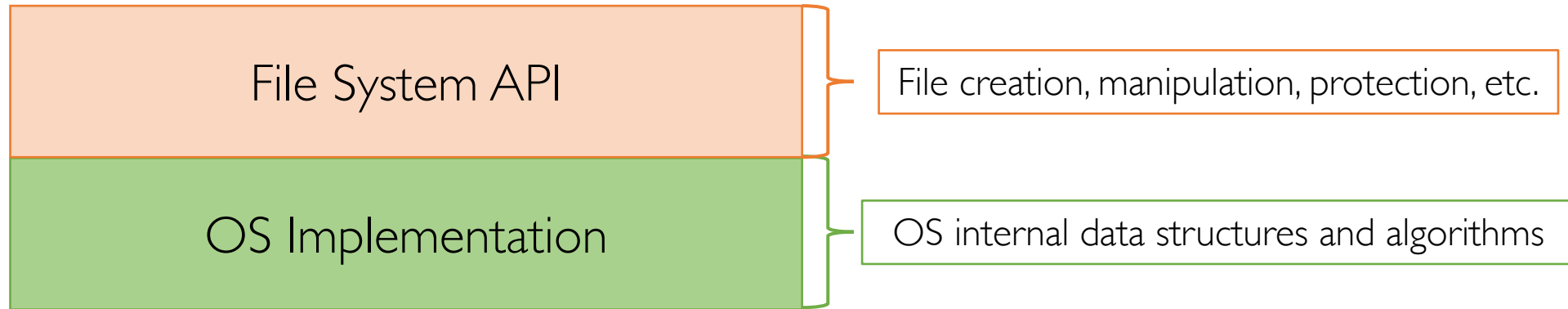


File System API

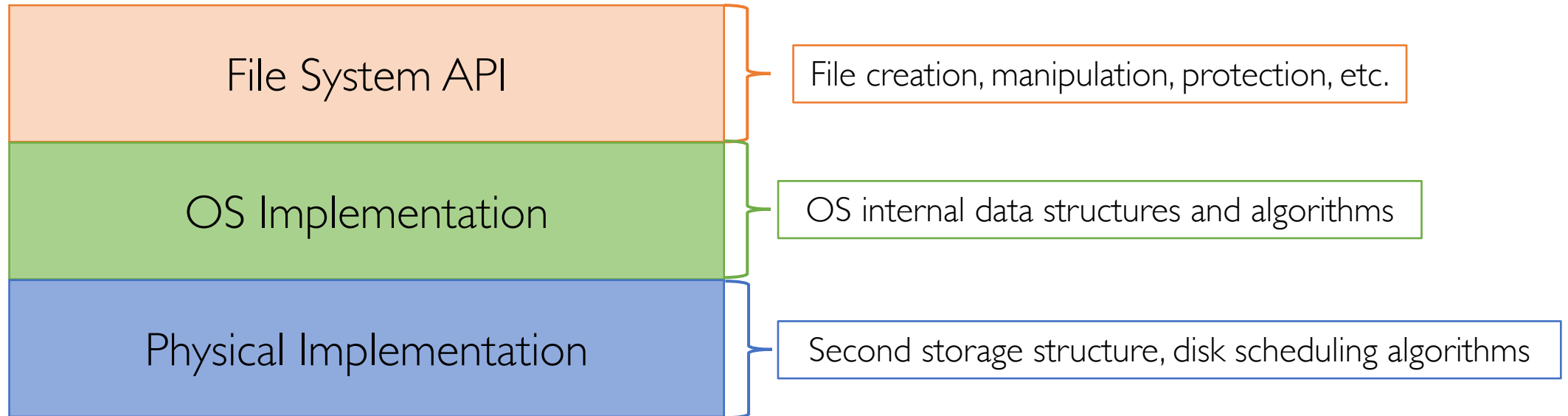
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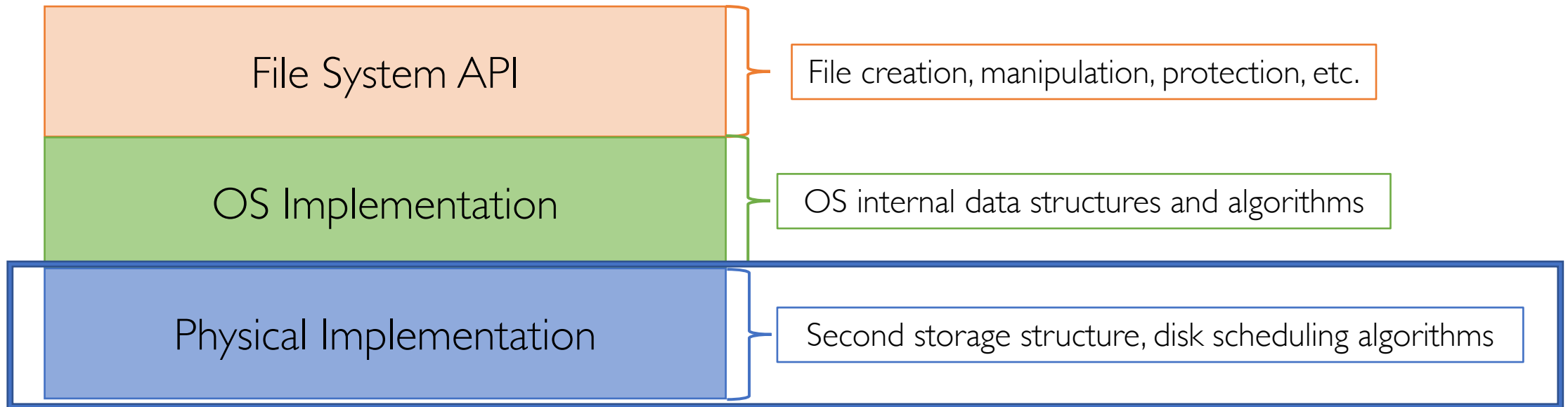
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# Part V: Storage Management

# Overview of Mass-Storage Structure

3 categories of mass-storage devices



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Magnetic Disks



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Solid-State Disks



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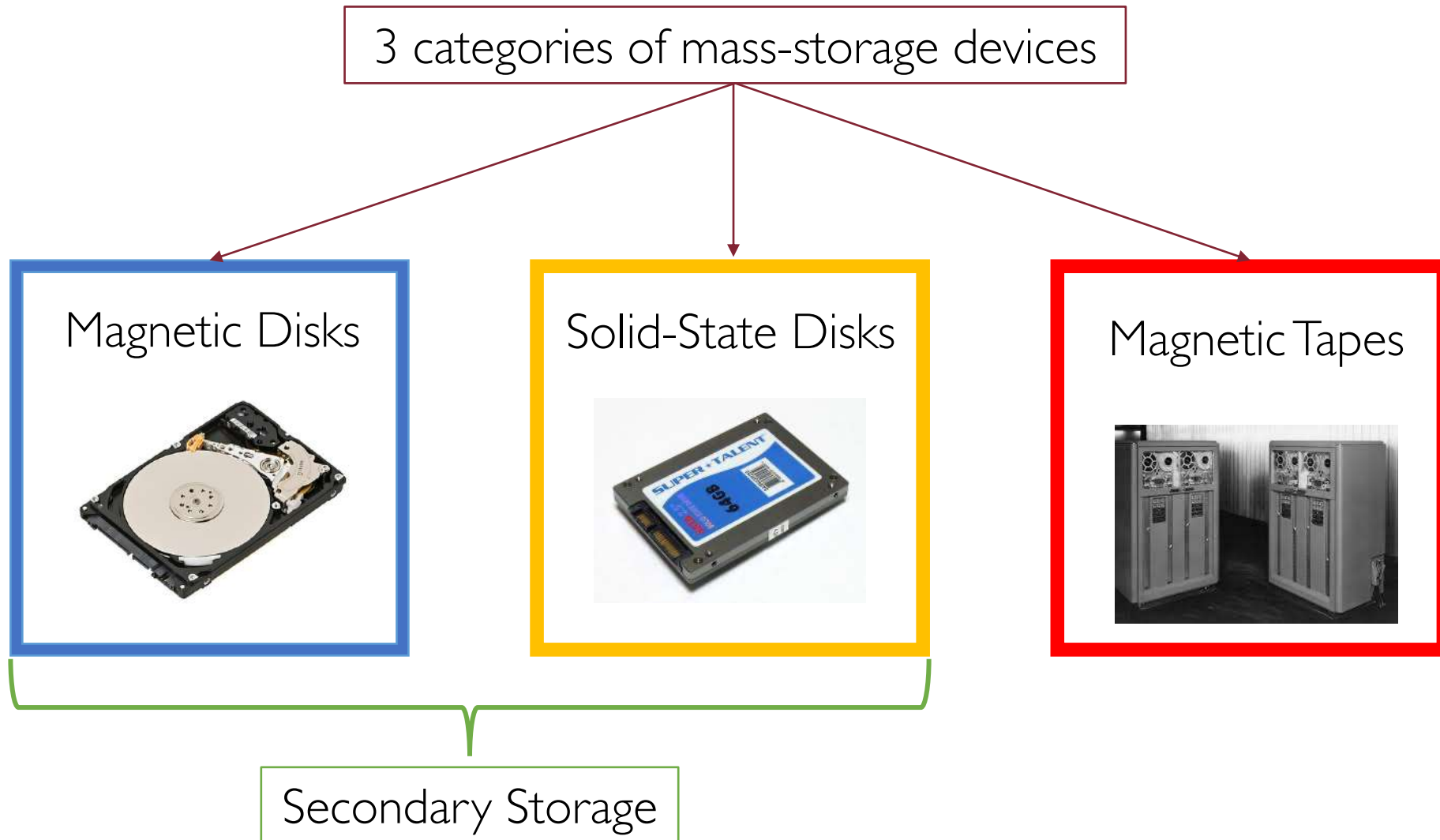
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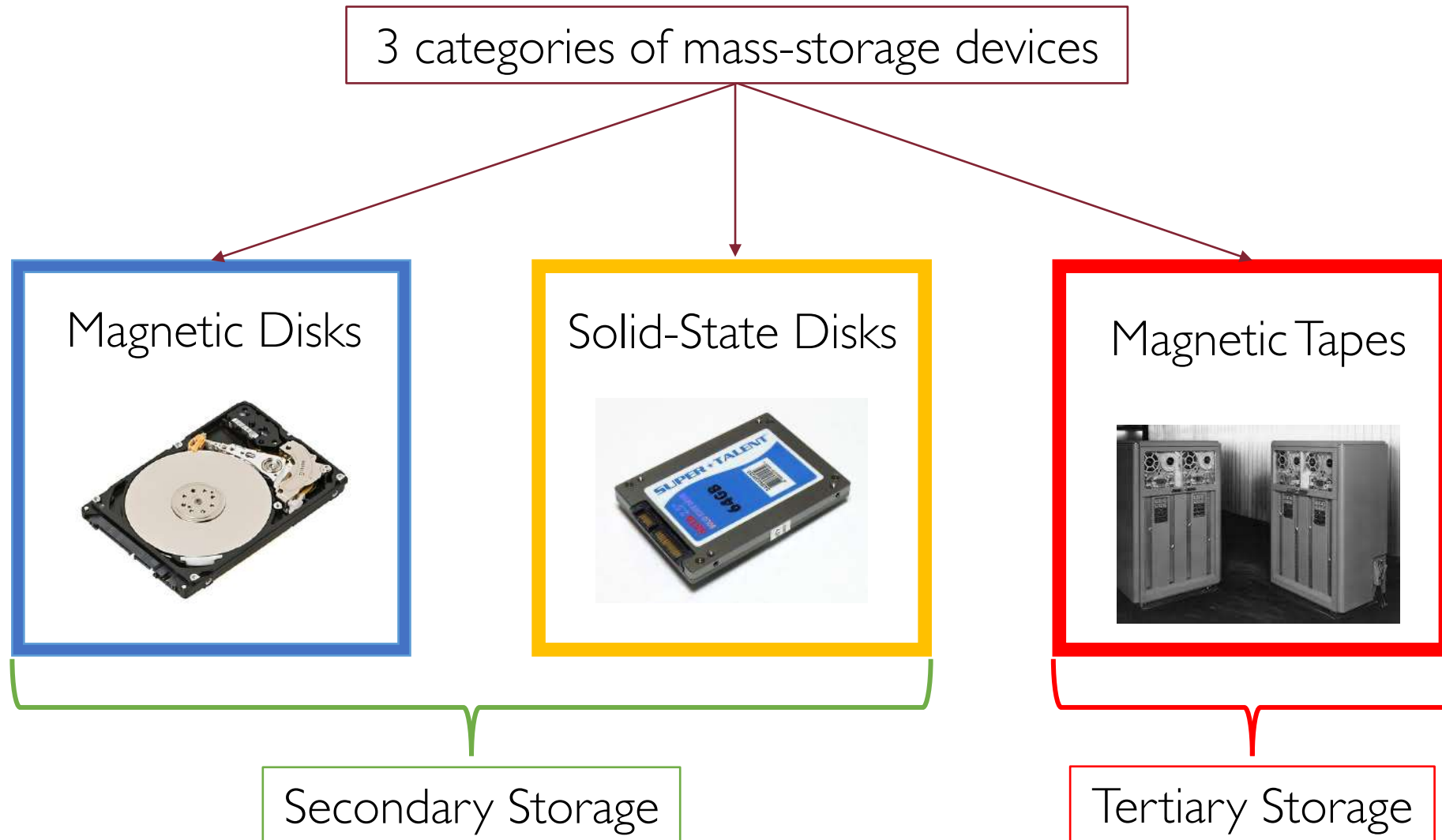
Magnetic Tapes



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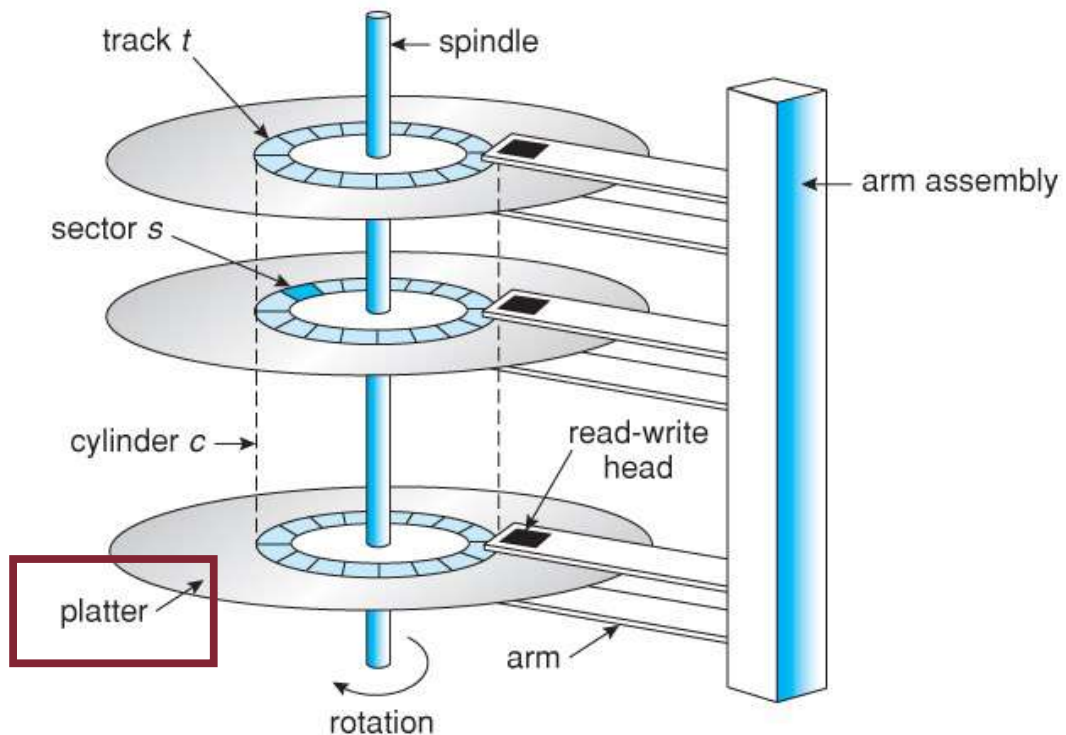


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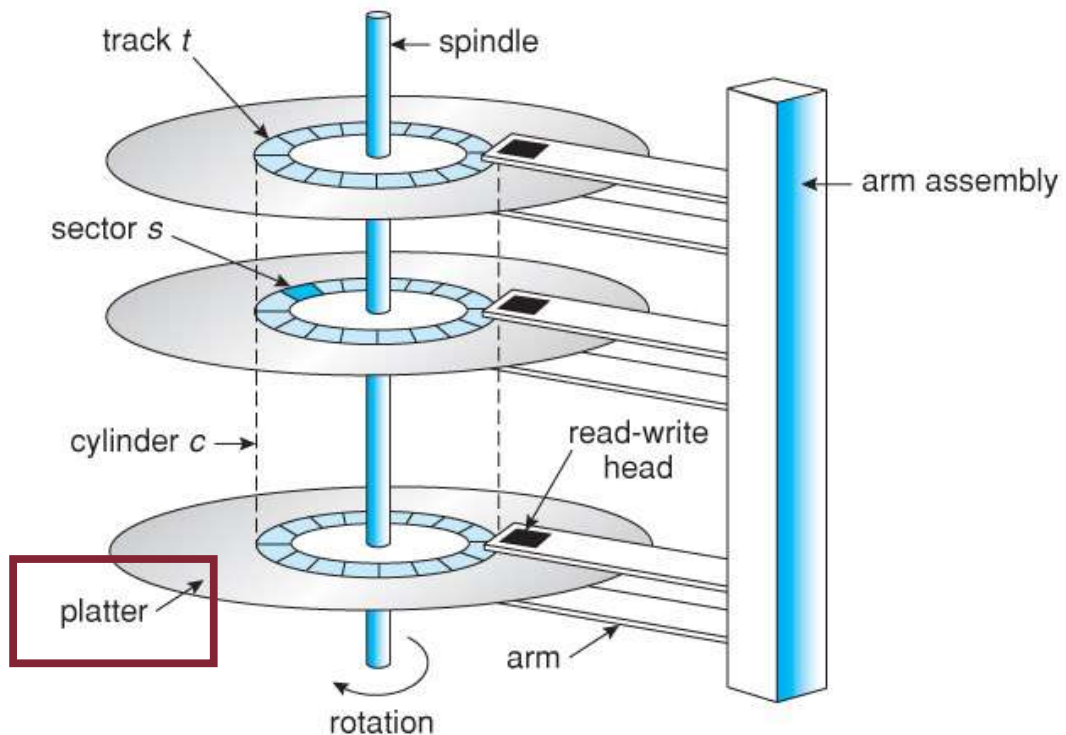


# Magnetic Disks: Structure

One or more **platters** covered with **magnetic** media



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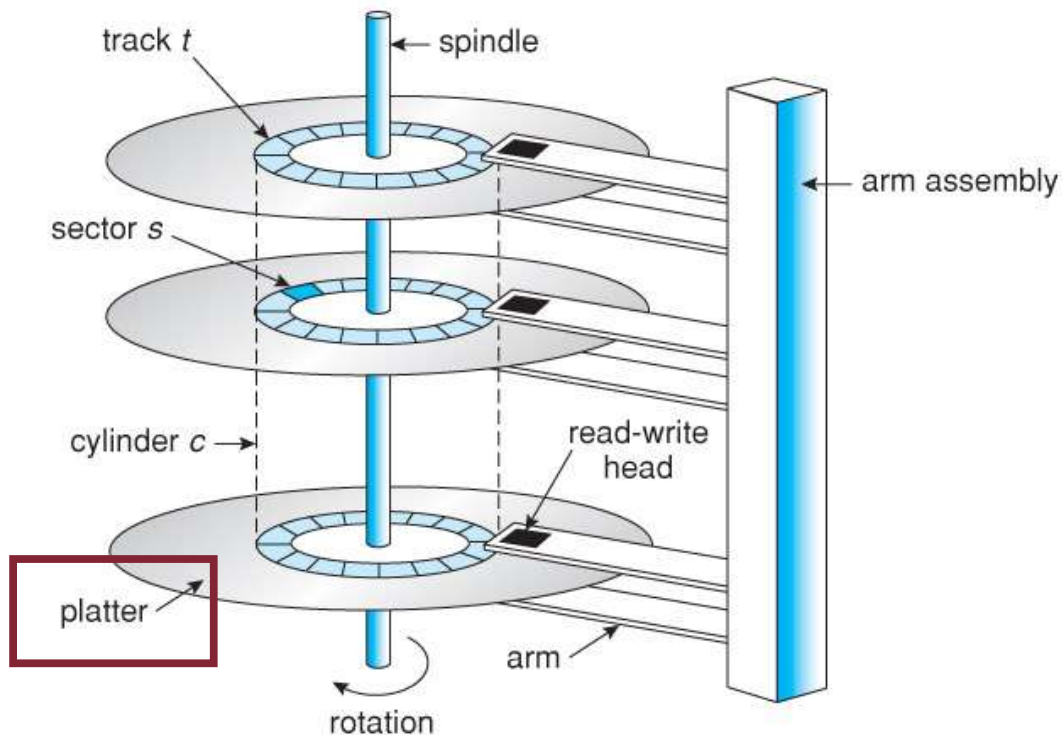


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Hard disk  
rigid metal



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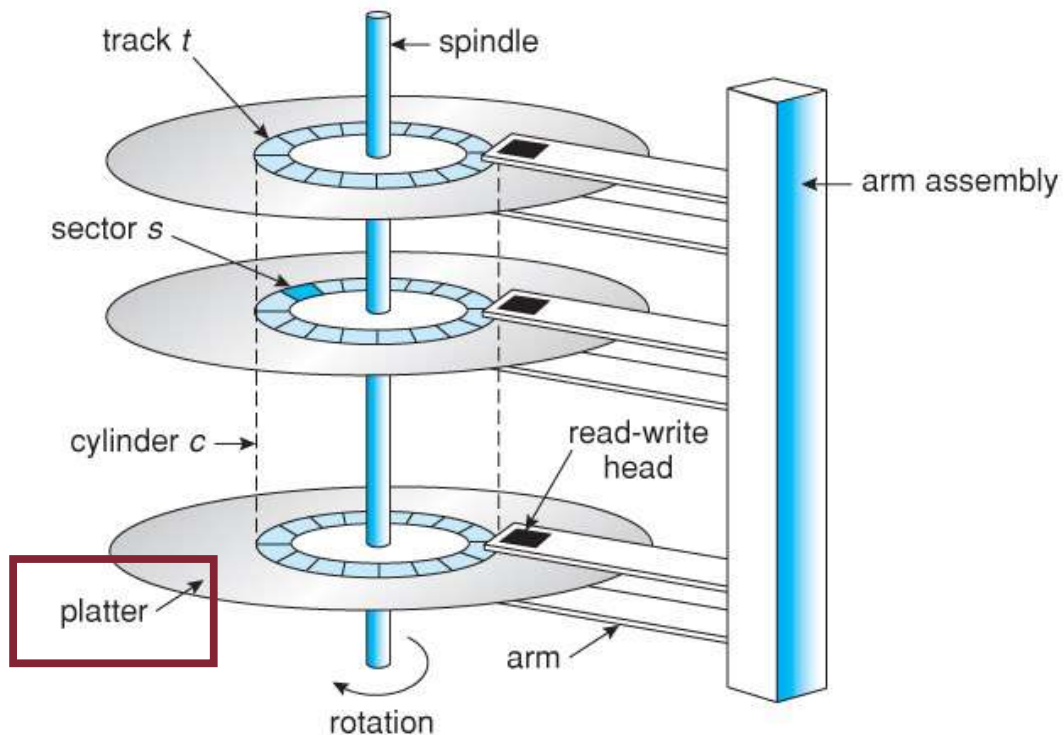


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flexible plastic

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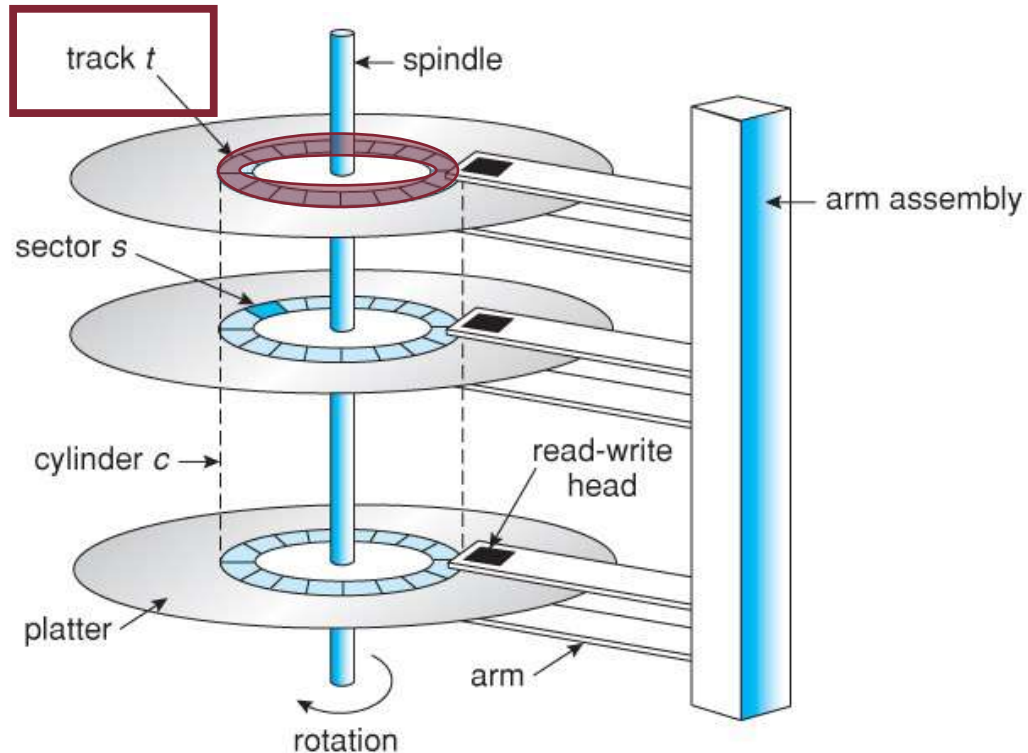
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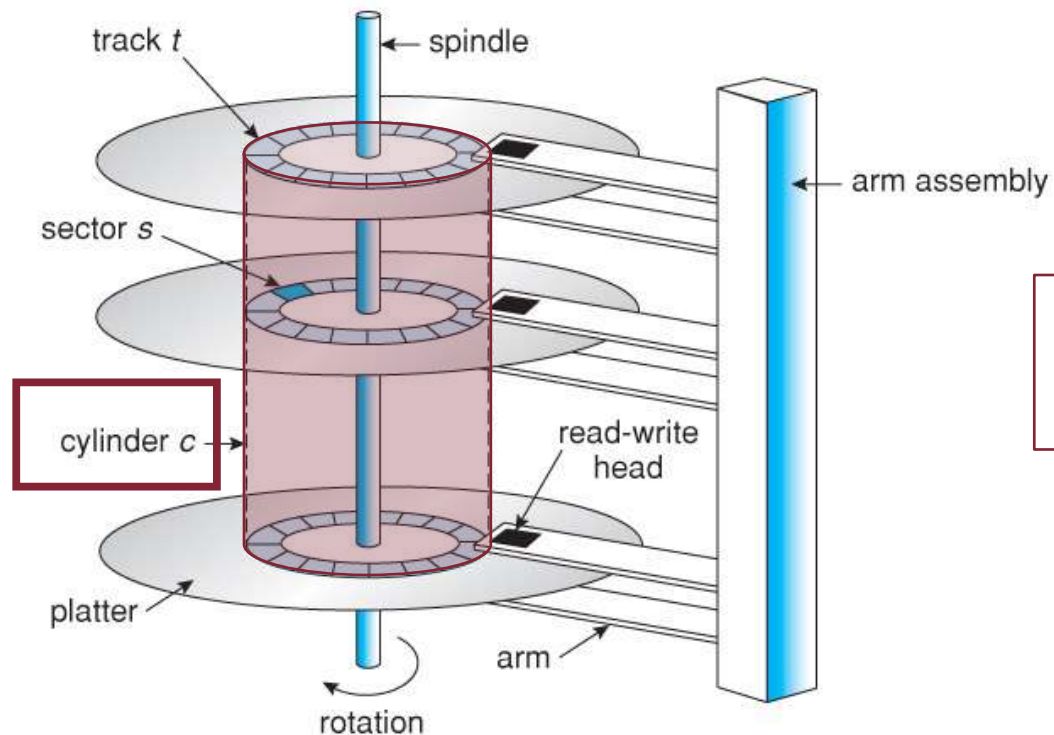
Each platter has **2** working **surfaces**

# Magnetic Disks: Tracks and Cylinders



Each surface is divided into a number of concentric rings, called **tracks**

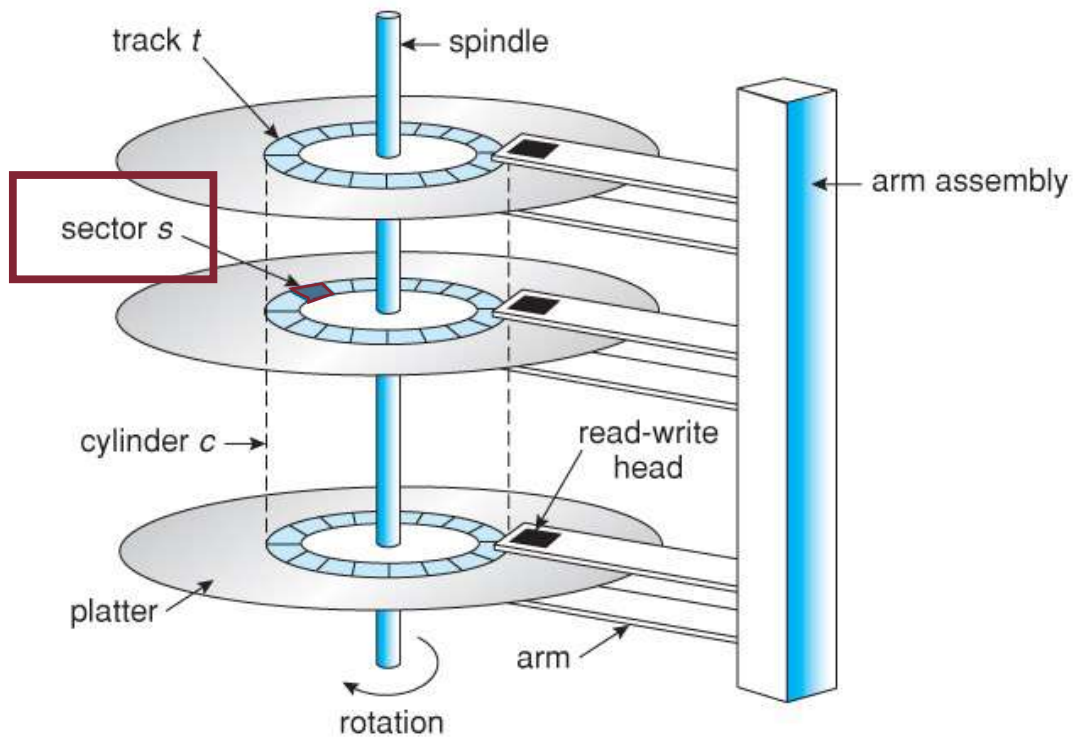
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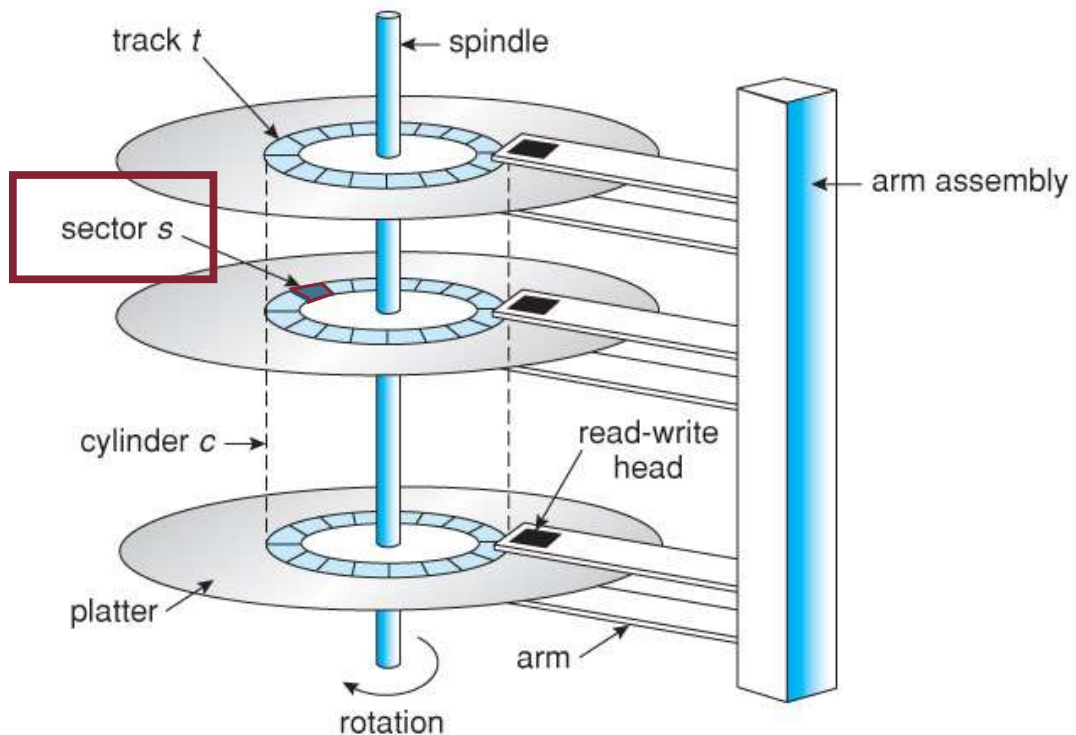
The set of all tracks that are the same distance from the edge of the platter is called a **cylinder**

# Magnetic Disks: Sectors



Each track is further divided into  
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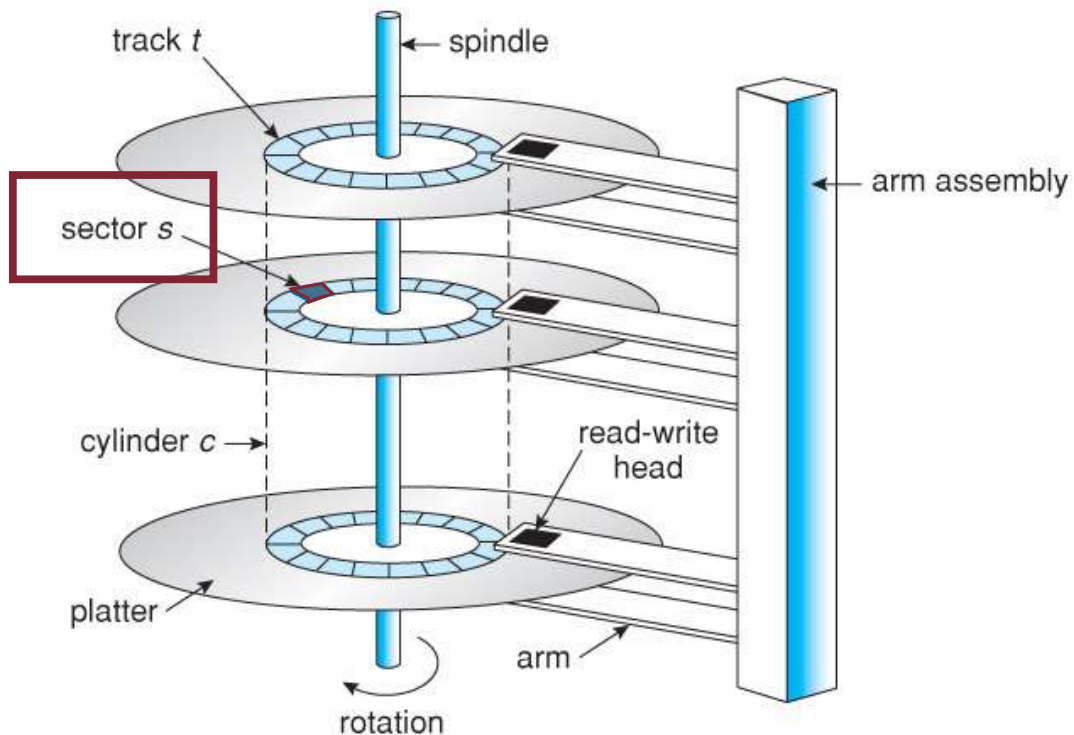
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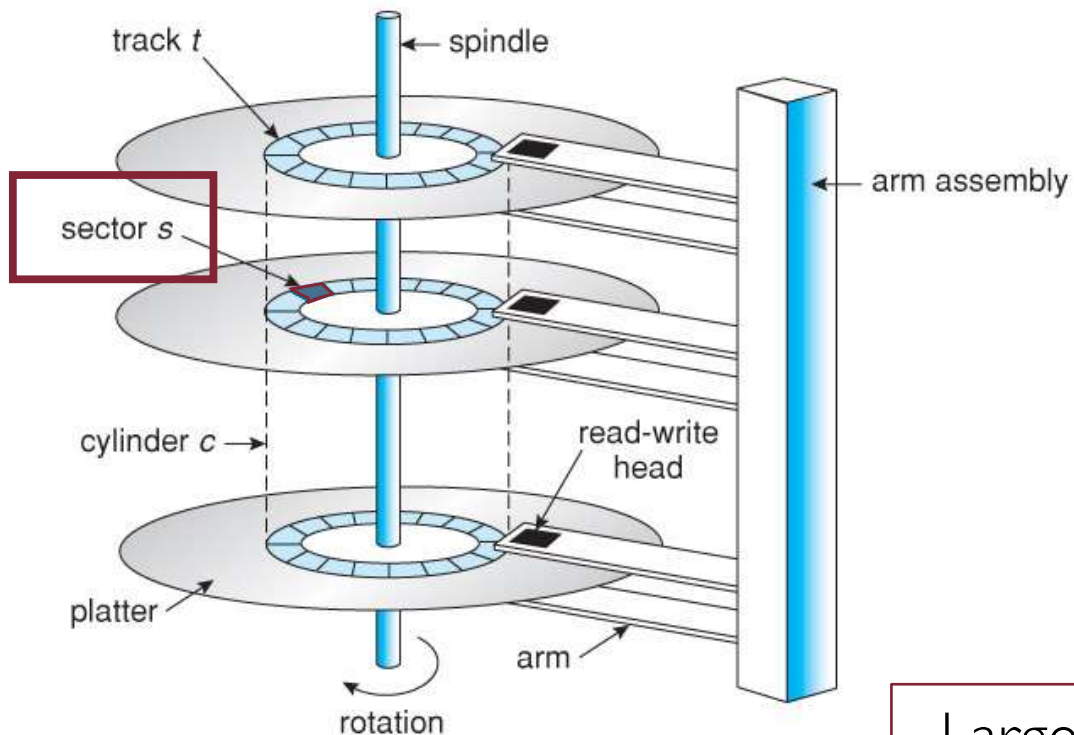


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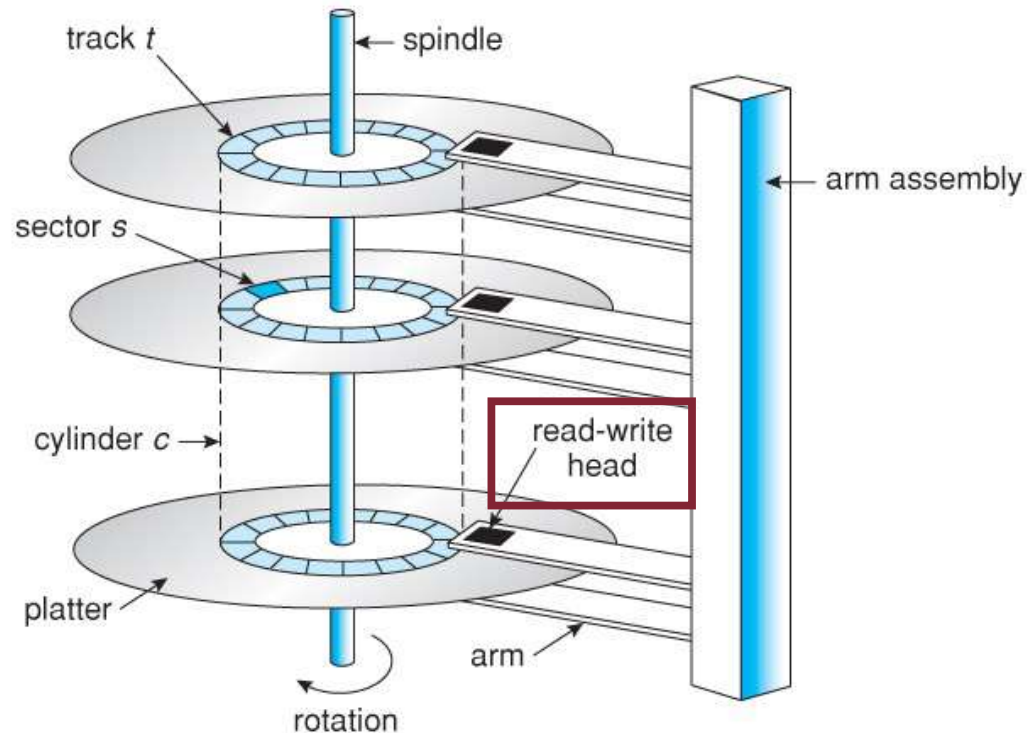
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Larger sector sizes reduce the space wasted by headers and trailers, but increase internal fragmentation

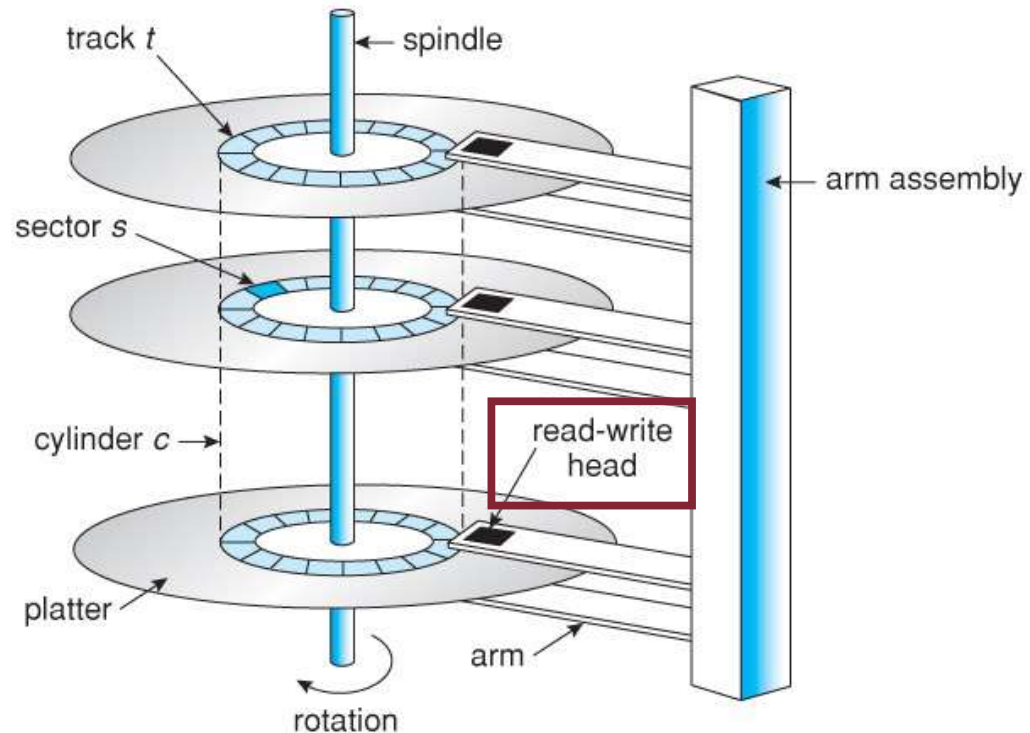


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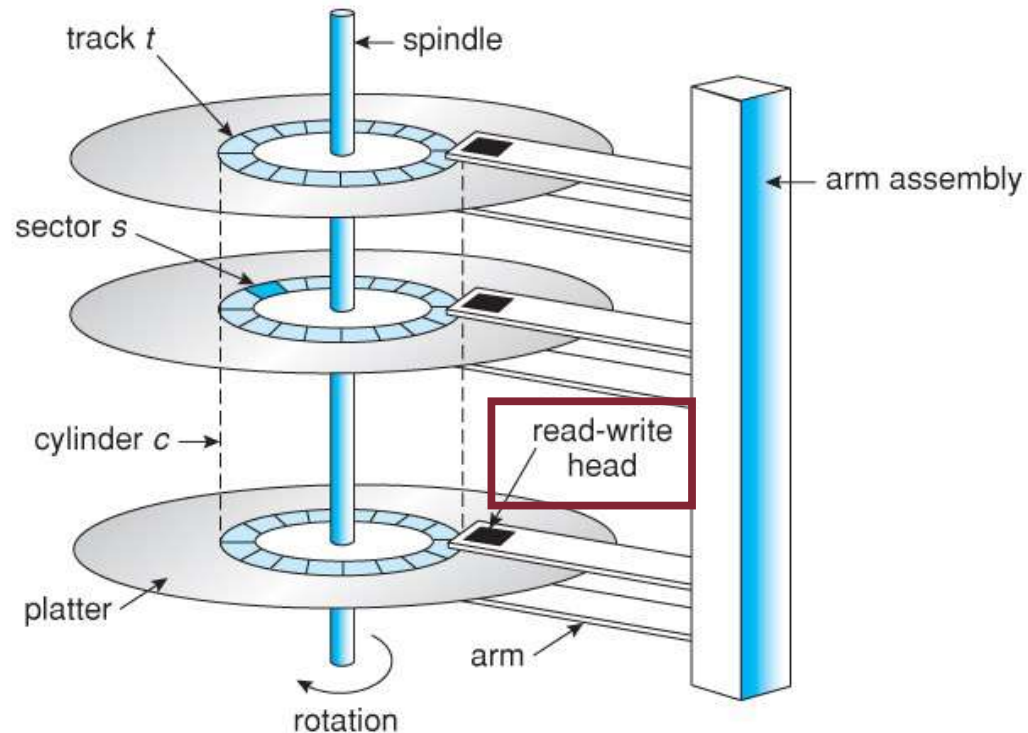
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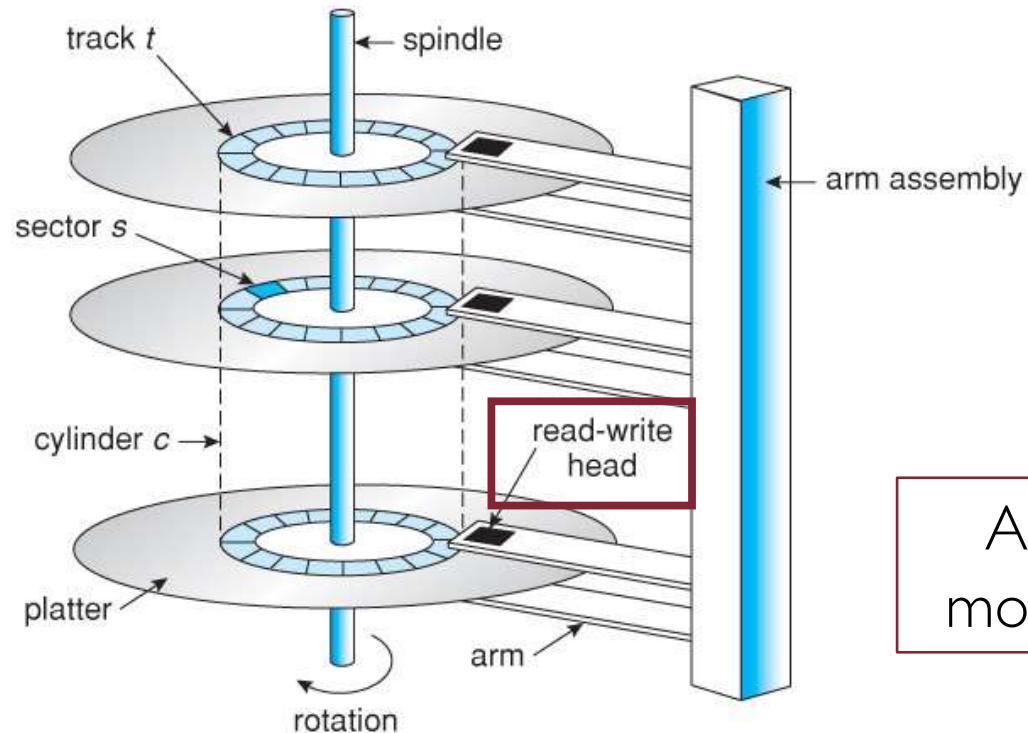


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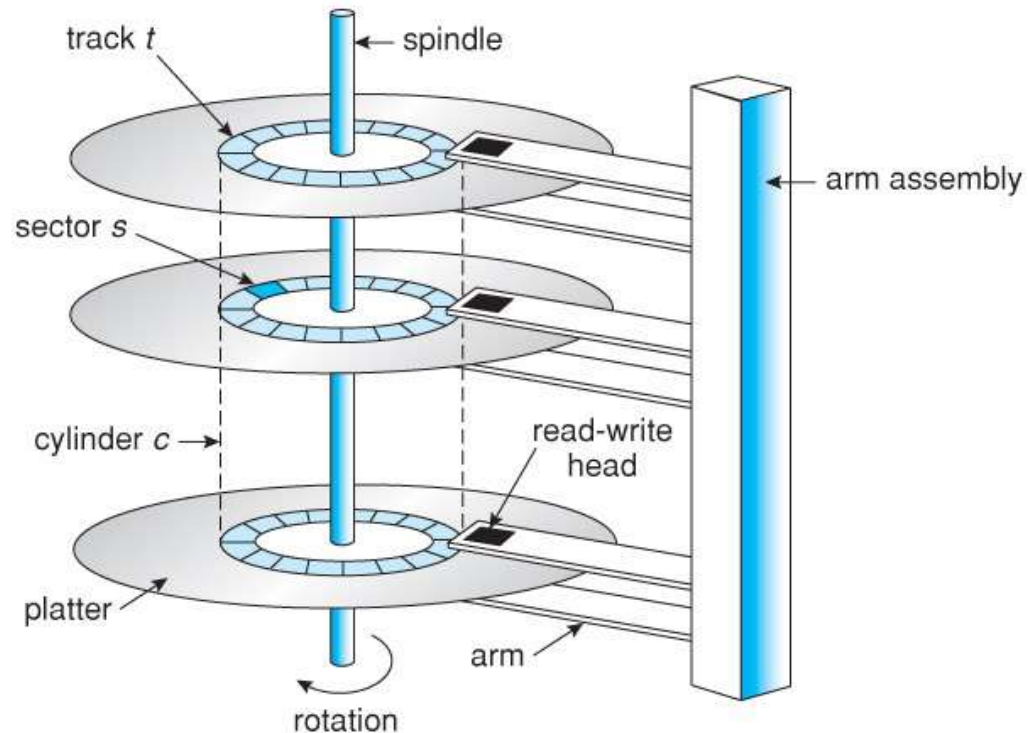
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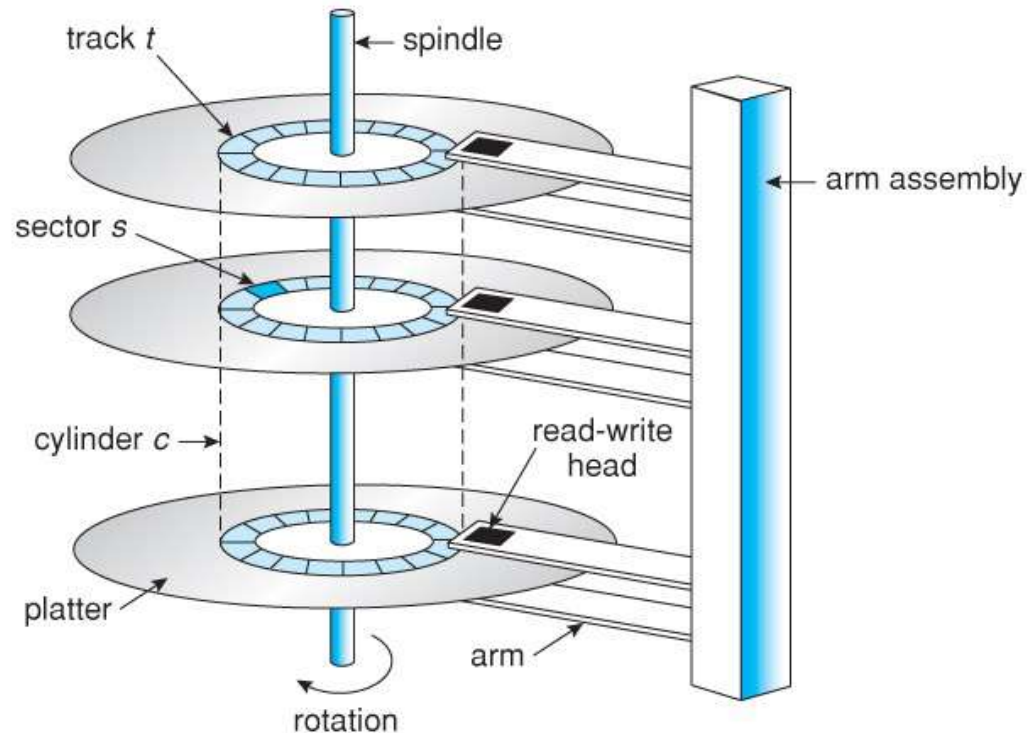
Arms are controlled by a common **arm assembly** moving simultaneously from one cylinder to another

# Magnetic Disks: Storage Capacity

$H$  = number of heads (working surfaces)



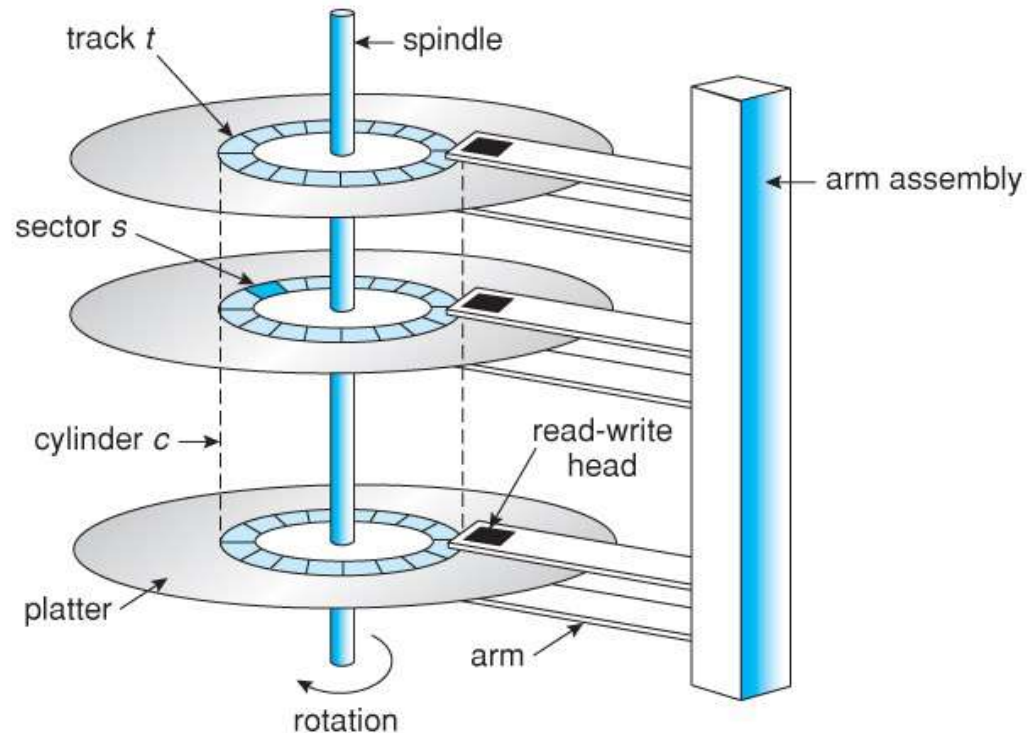
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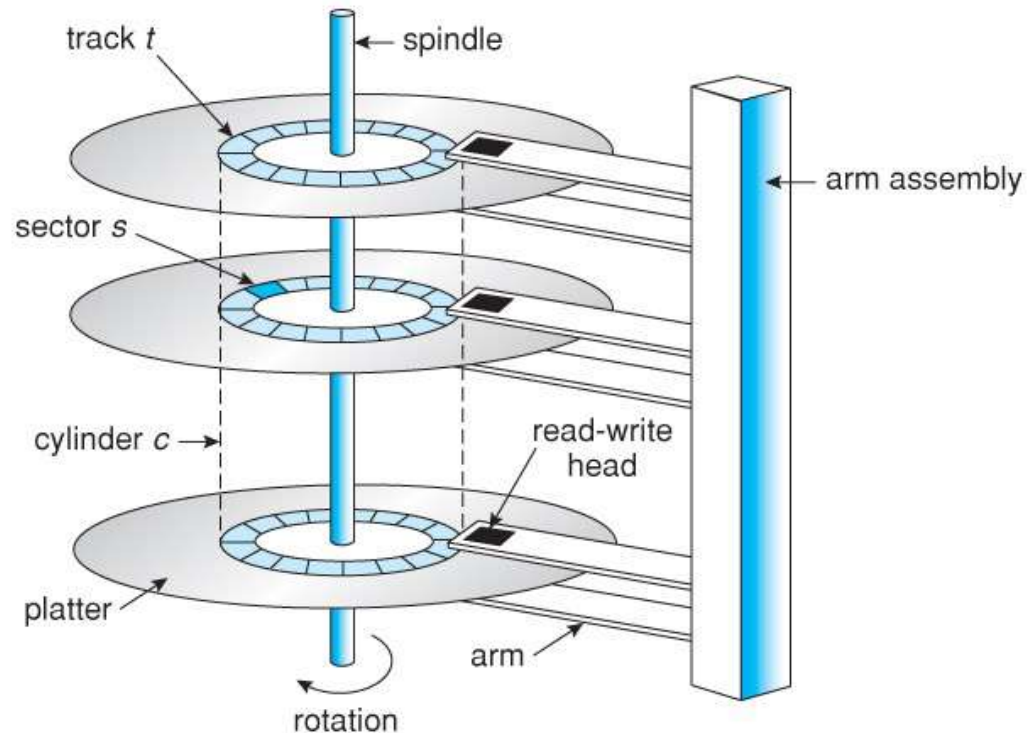


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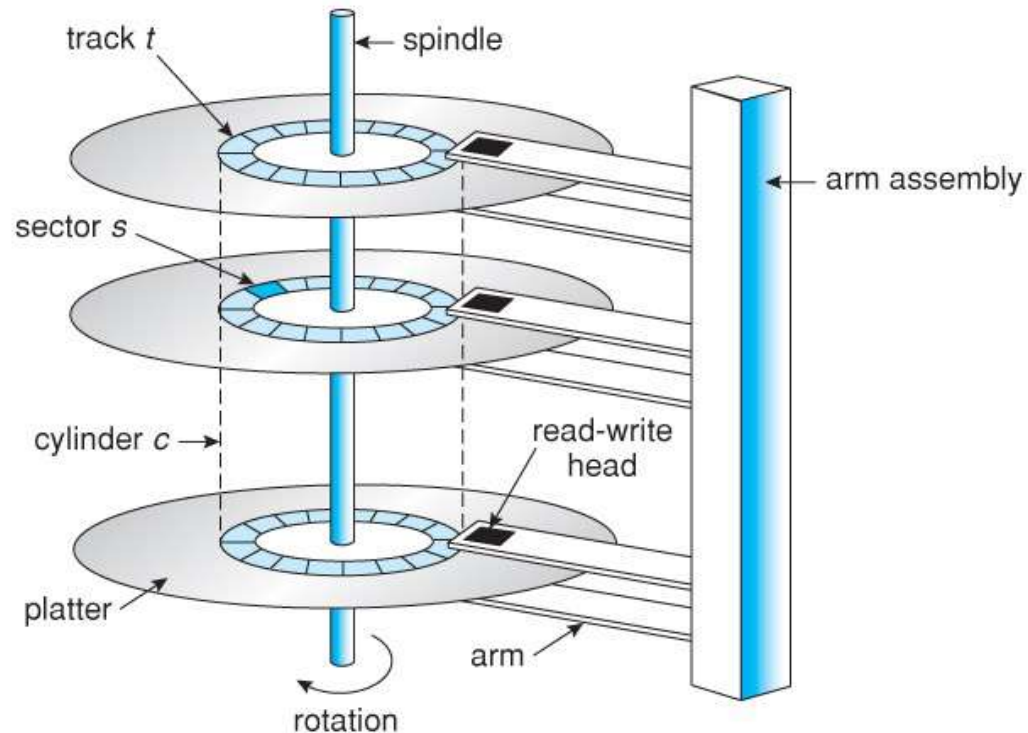
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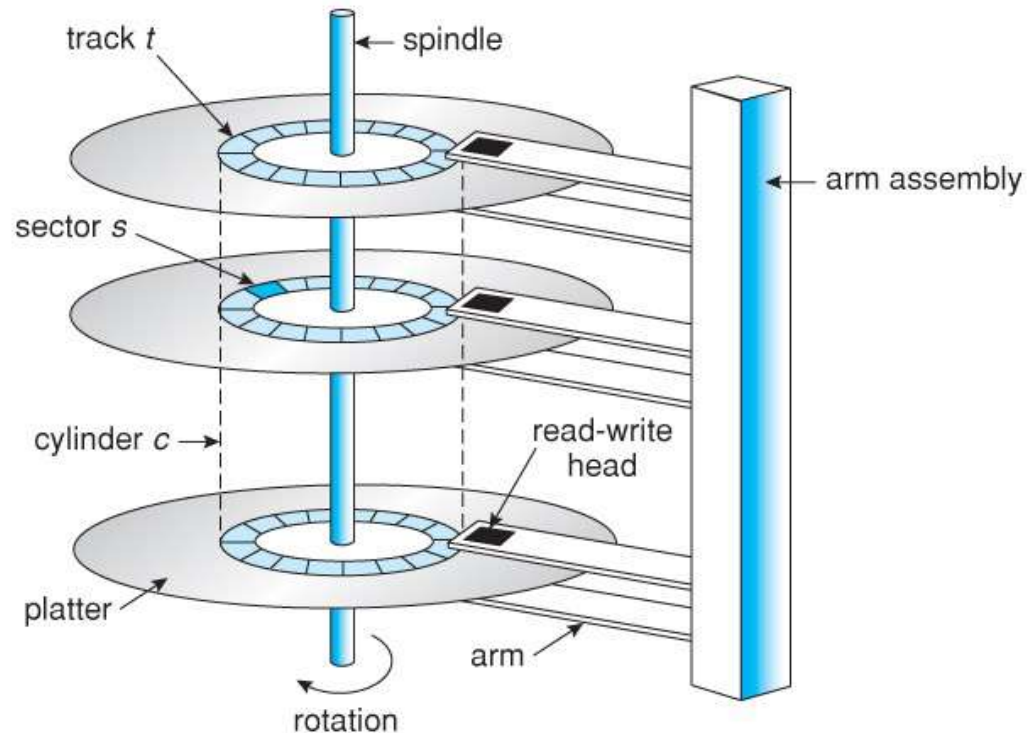
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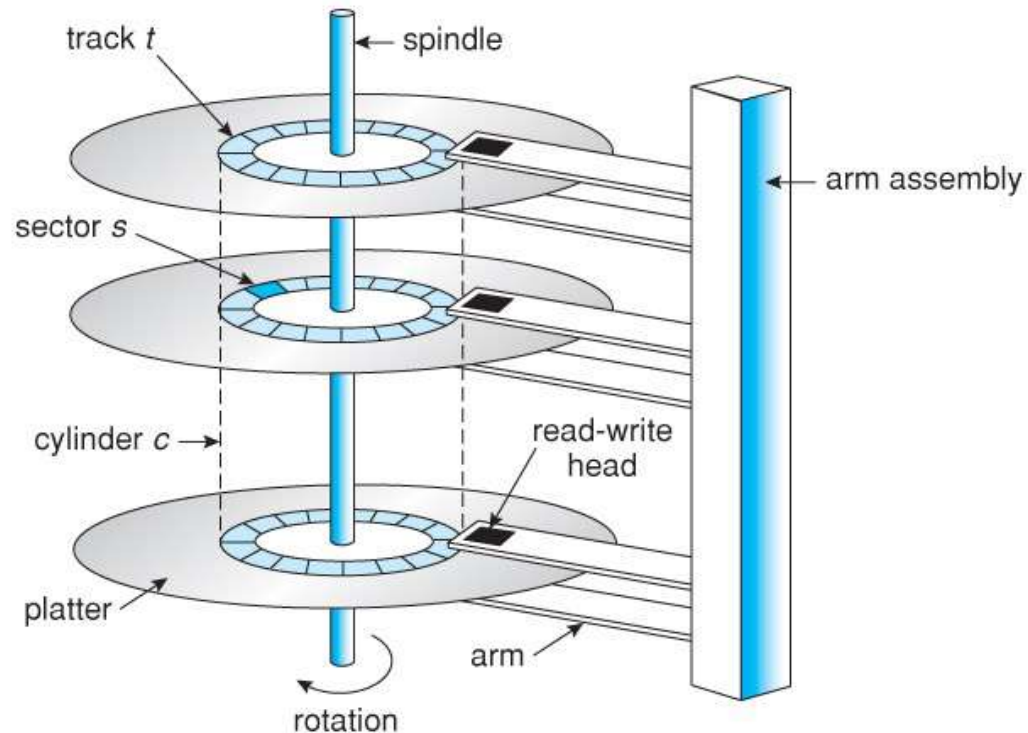
OVERALL CAPACITY

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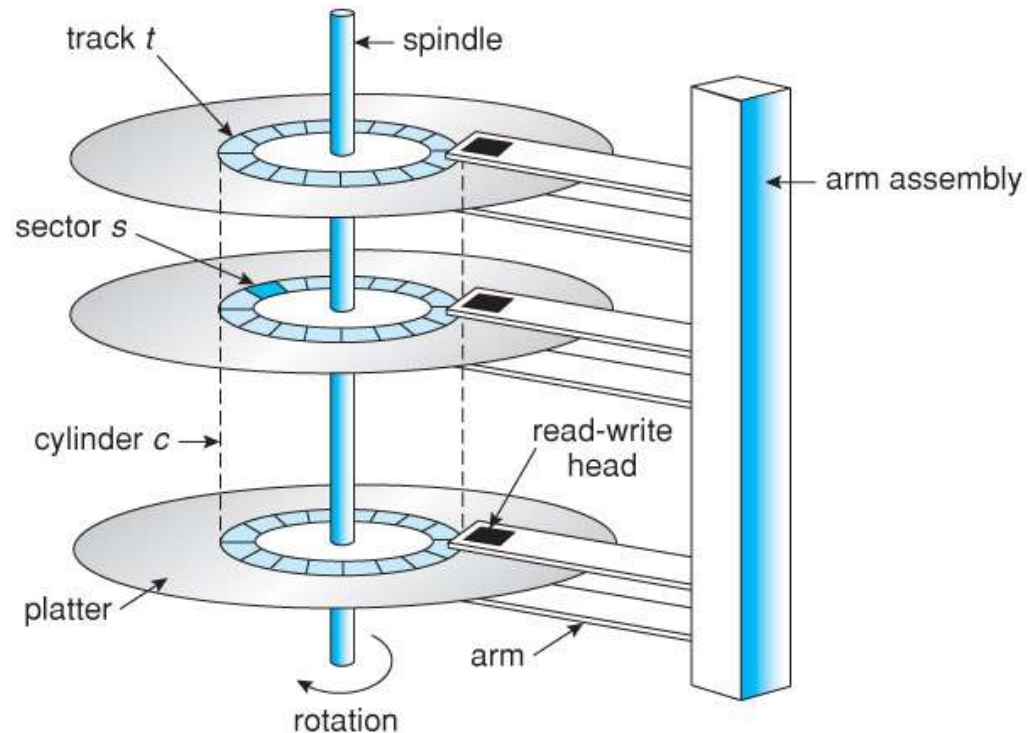
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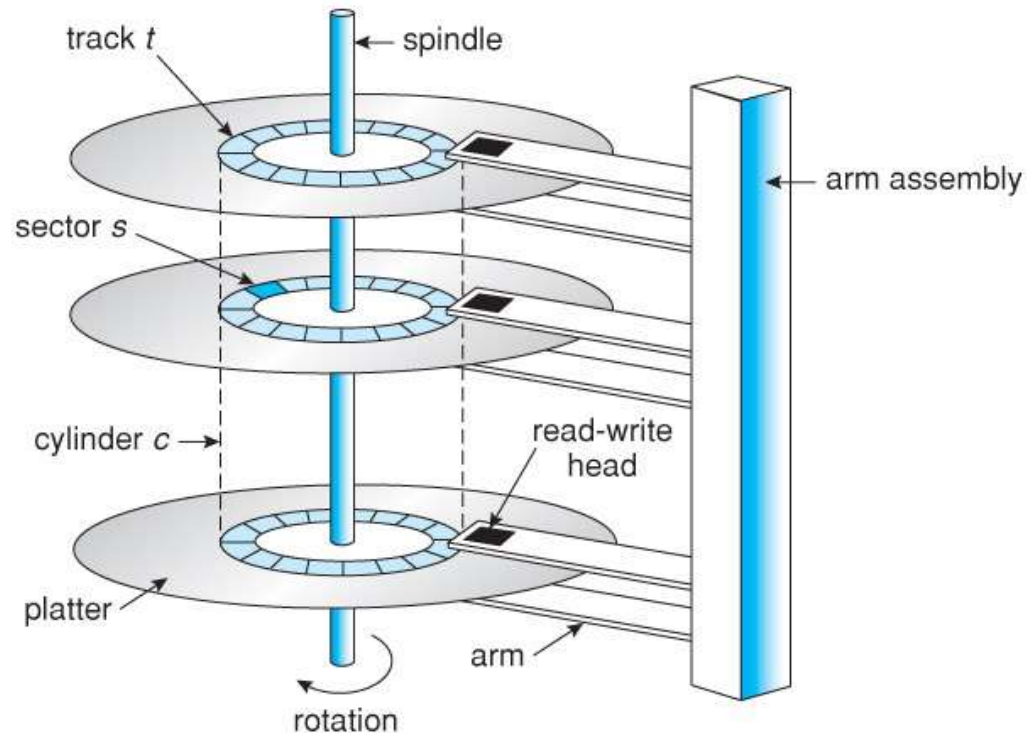


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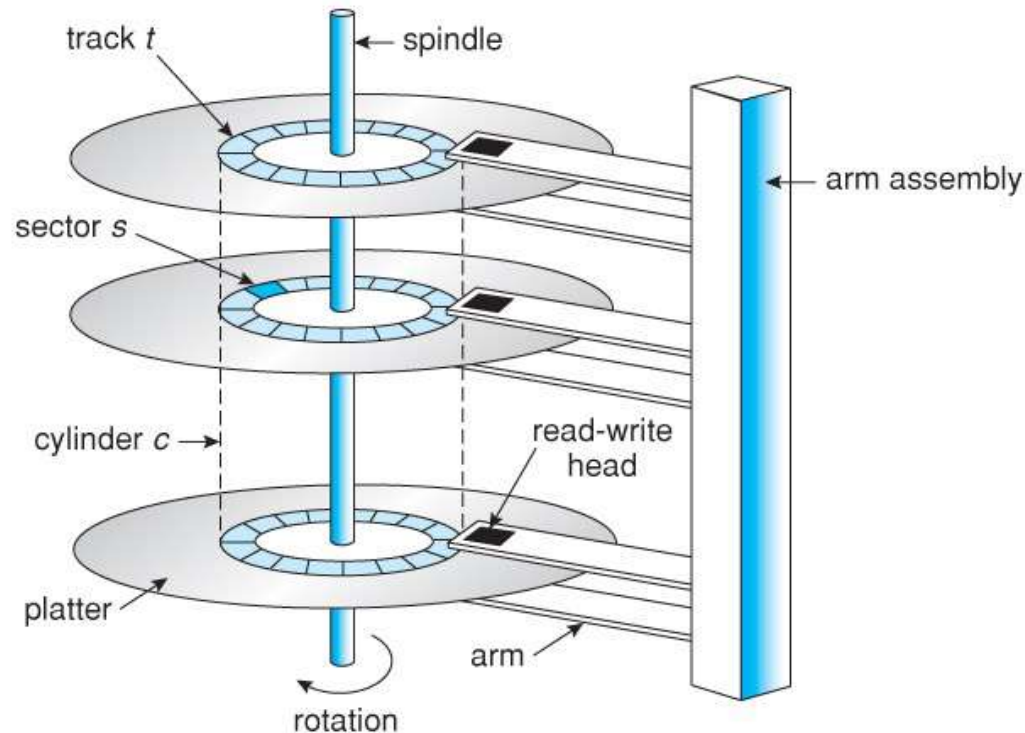
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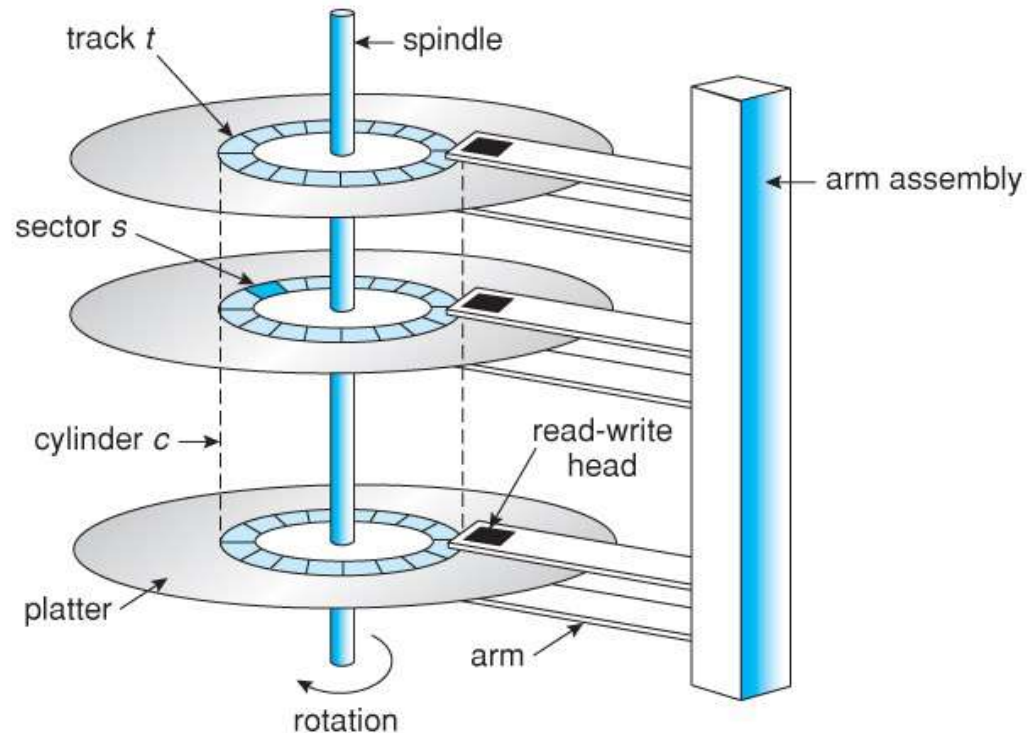
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- Different frequencies and timing from innermost to outermost tracks

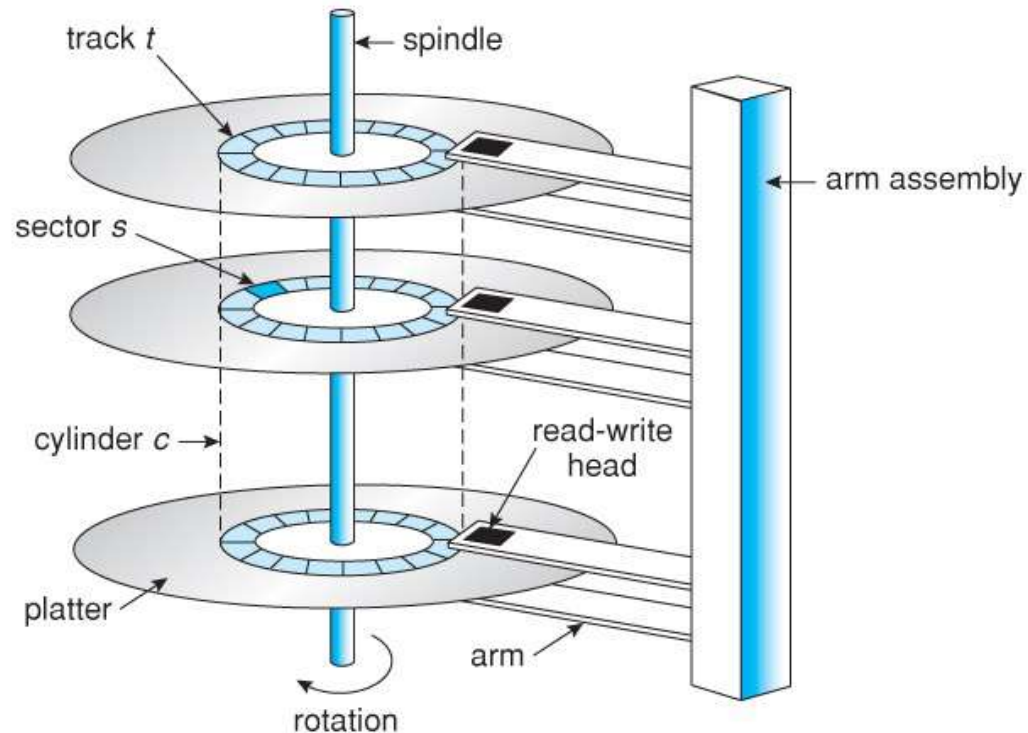
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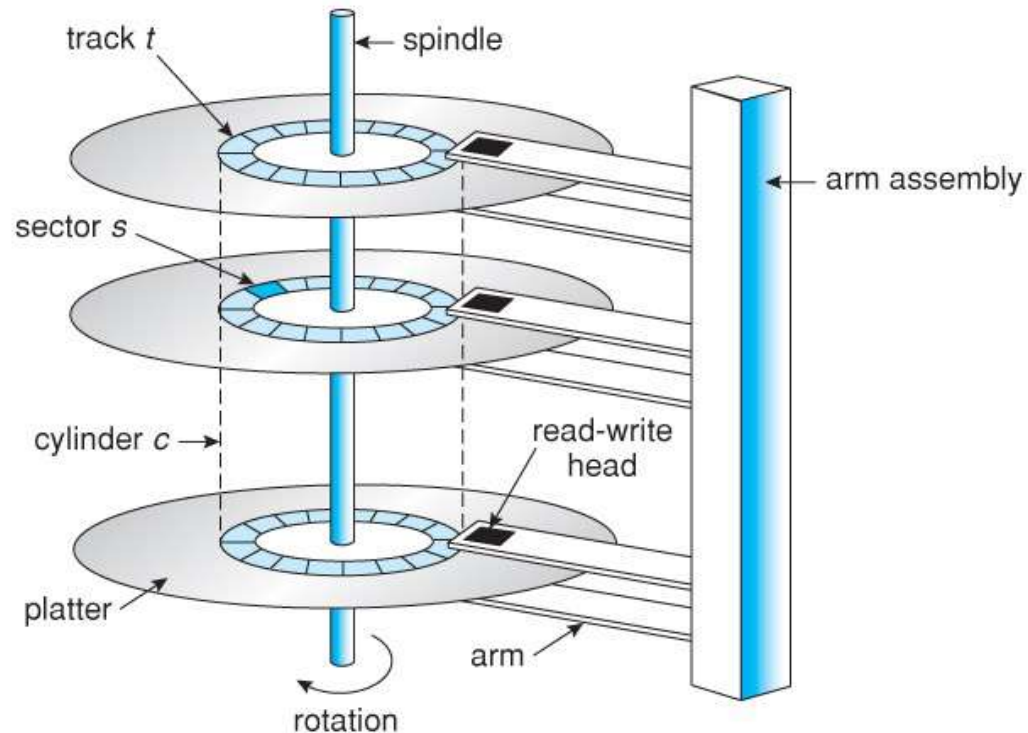


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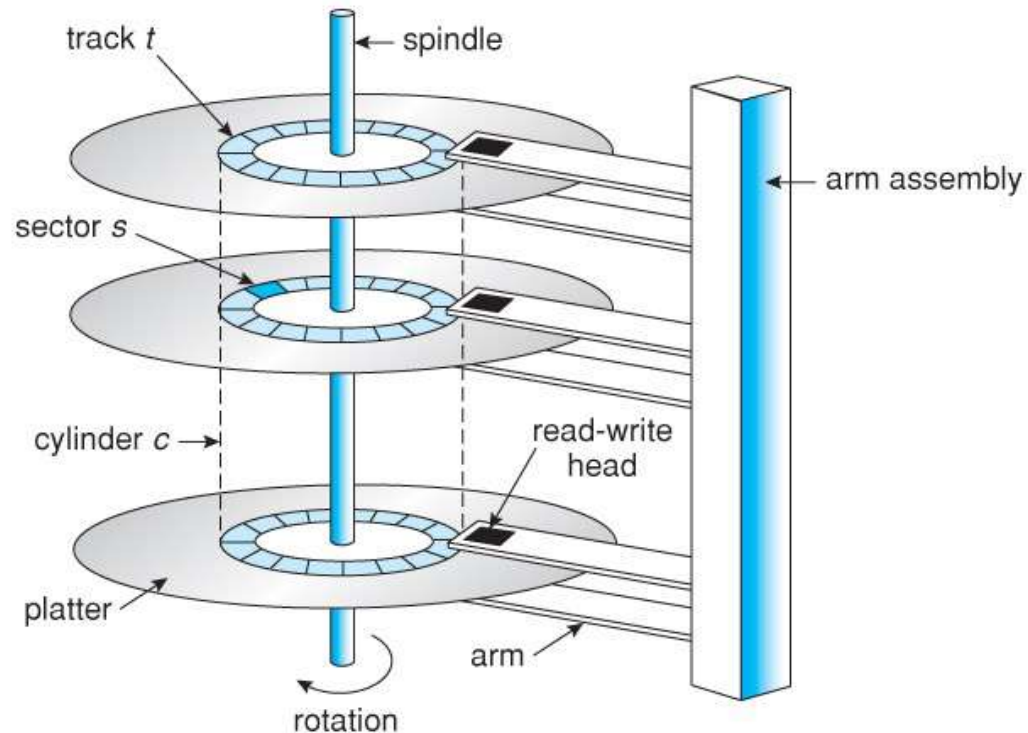


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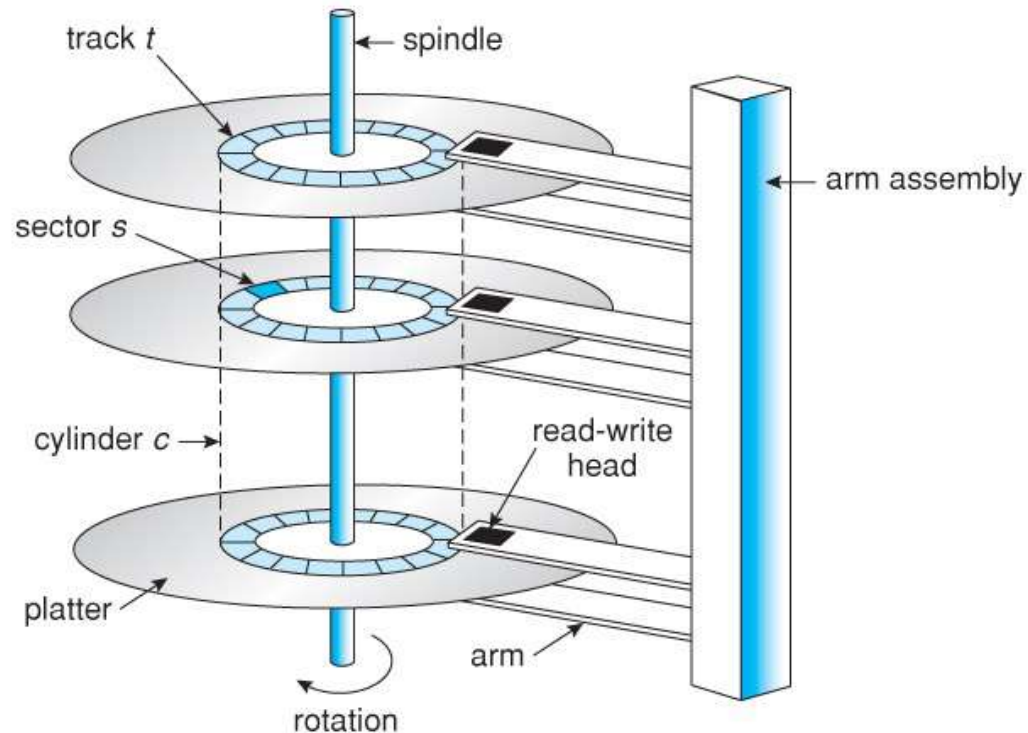
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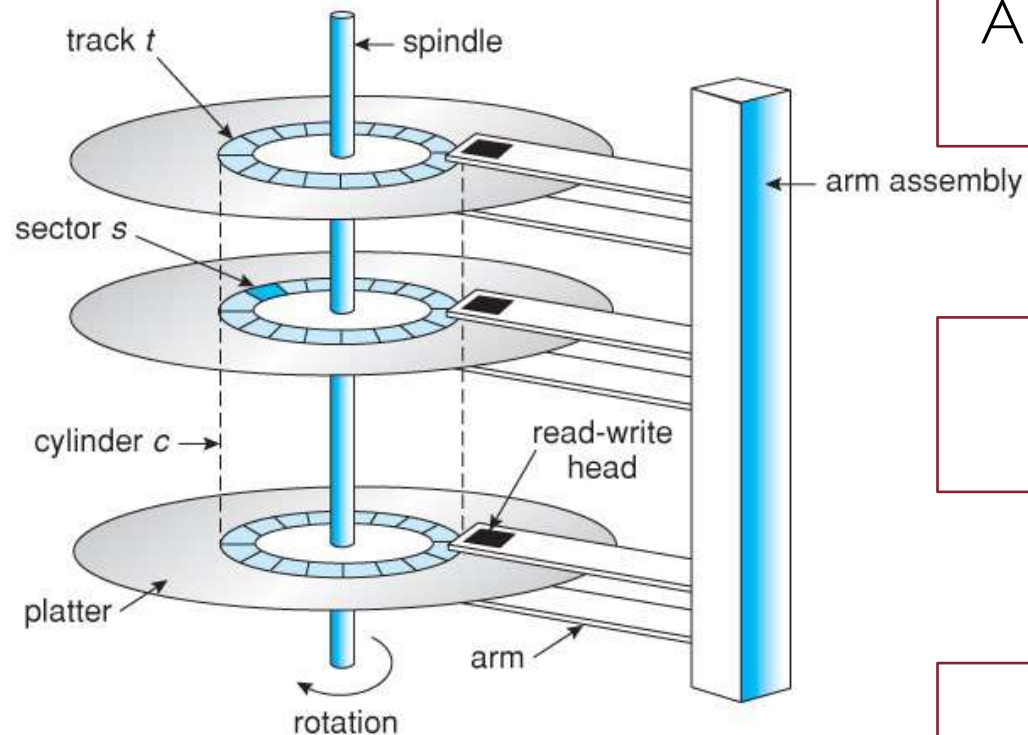
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Zone Bit Recording (ZBR)

# Magnetic Disks: (Logical) Referencing



A physical block of data is specified by the (head, cylinder, sector) number

Disk blocks are numbered starting at the outermost cylinder, identified by 0

Note that cylinder coincides with track

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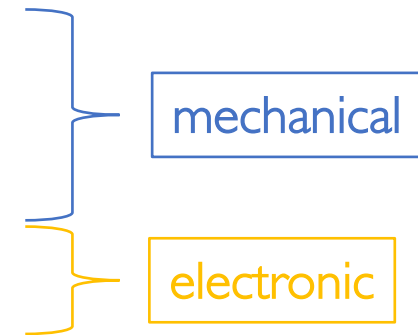
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mechanical

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- The time required to move the heads to a specific track/cylinder
- Includes the time needed for the heads to settle after the move
- Depends on how fast the hardware moves the assembly arm
- Typically, the slowest step in the entire process

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Bottleneck of overall disk data transfer

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The second highest bottleneck



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$$\text{Data Transfer Time} = \text{Seek Time} + \text{Rotational Delay} + \text{Transfer Time}$$

Sometimes the term **transfer rate** is used to refer to the overall data transfer time

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- Sector 0 is the first sector of the first track of the outermost cylinder
  - The mapping proceeds in order through that track
  - Then through the rest of tracks in the same cylinder
  - Then through other cylinders (from the outermost to innermost)

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- Parking heads means to move them off the disk or to an area where no data is stored

# Magnetic Disks: Interfaces

- Hard drives may be removable as floppy disks, and some are even hot-swappable
  - they can be removed while the computer is running
- Disk drives are connected to the computer via the I/O bus
- Some of the common interface formats include:
  - Enhanced Integrated Drive Electronics (EIDE);
  - Advanced Technology Attachment (ATA) and Serial ATA (SATA);
  - Universal Serial Bus (USB);
  - Fiber Channel (FC);
  - Small Computer Systems Interface (SCSI)

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- Data is transferred between the magnetic surface and onboard **cache** by the disk controller
- Finally, data is transferred from that cache to the host controller and the motherboard memory at electronic speeds

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Hardware Optimization

# Minimize Data Transfer Time

- How can the OS help minimize data transfer time?
- Schedule disk operations so as to minimize head movement
- Lay out data on disk so that related data are located on close tracks
- Place commonly-used data on a specific portion of the disk
- Pick carefully the block size contained on each sector:
  - Too small → more seeks are needed to transfer the same amount of data
  - Too large → more internal fragmentation and space wasted

# Summary

- Disks are slow devices compared to CPUs (and main memory)
- Manage those device efficiently is crucial
- Minimize seek and rotational delay on magnetic disks
- HW optimizations are limited → OS needs to take the lead here!