

# Sistemi Operativi I

Corso di Laurea in Informatica  
2023-2024



**SAPIENZA**  
UNIVERSITÀ DI ROMA

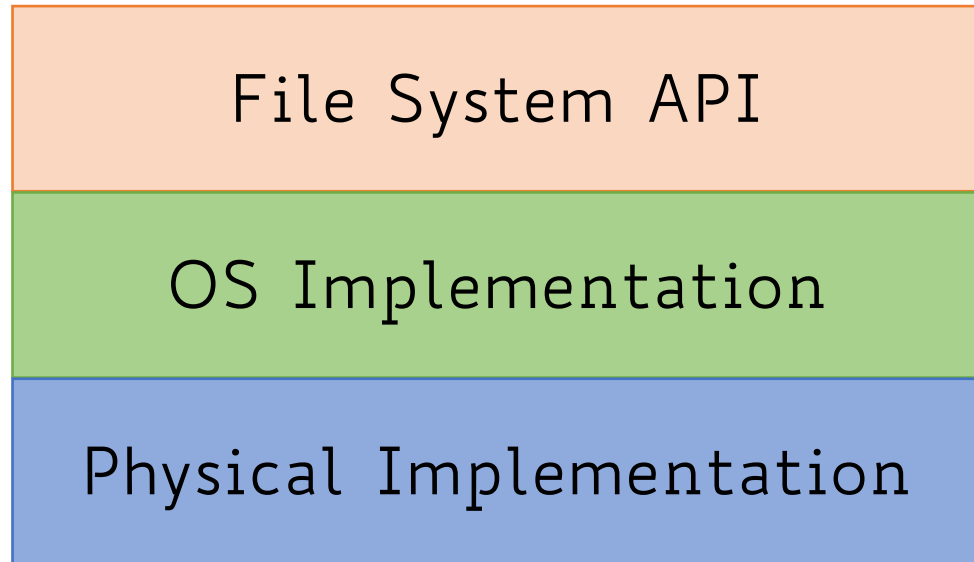
Gabriele Tolomei

Dipartimento di Informatica

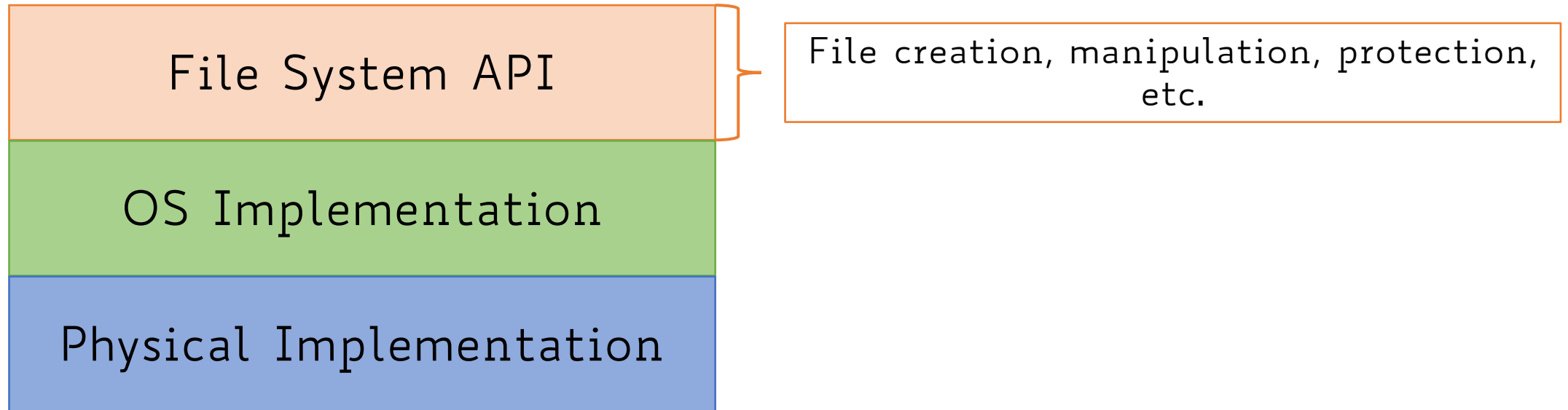
Sapienza Università di Roma

[tolomei@di.uniroma1.it](mailto:tolomei@di.uniroma1.it)

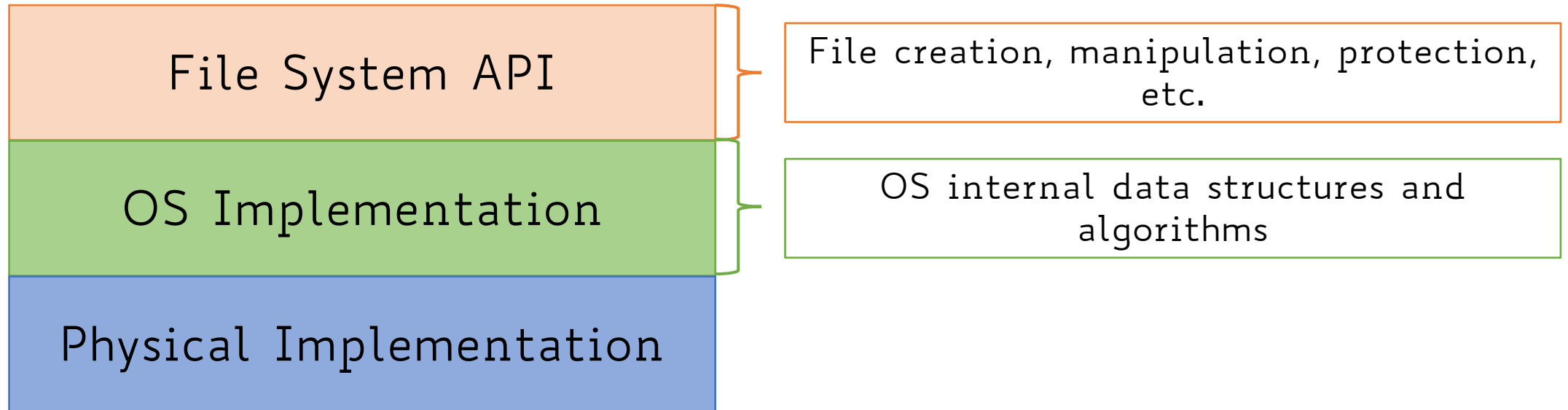
# File System's Logical View



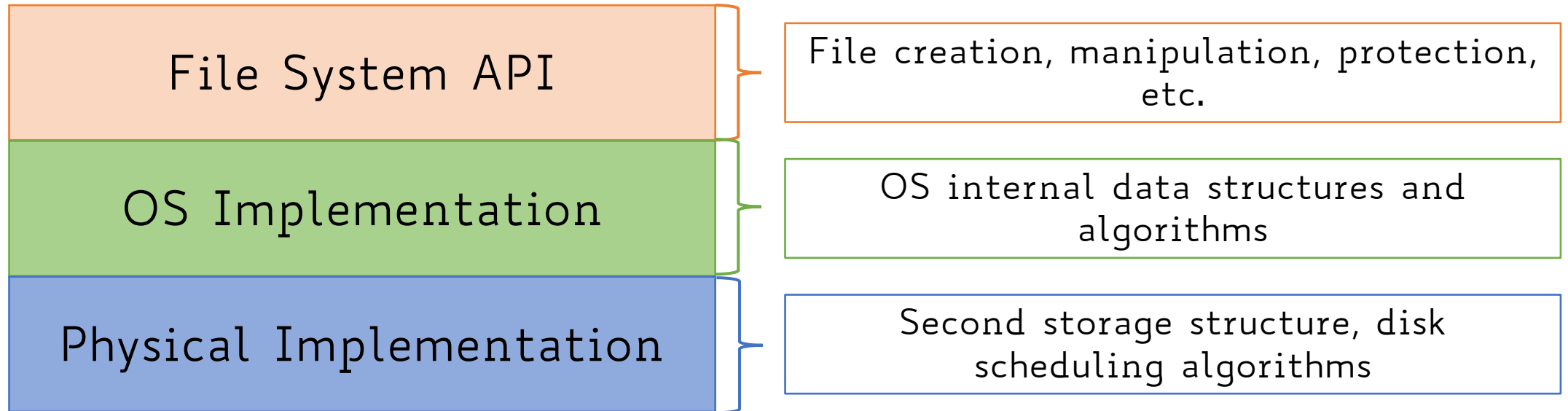
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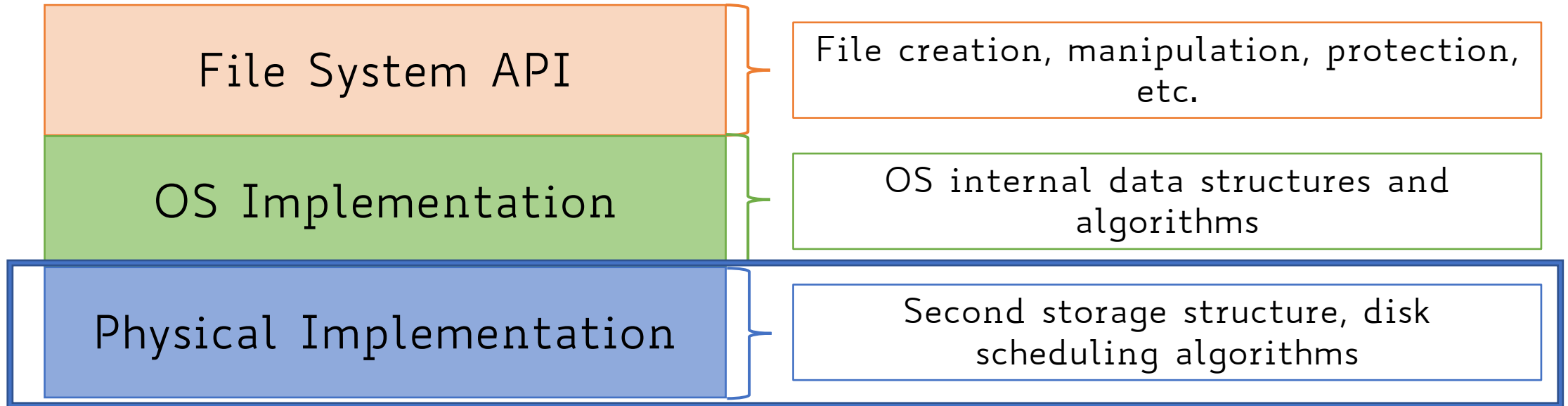
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# Part V: Storage Management

# 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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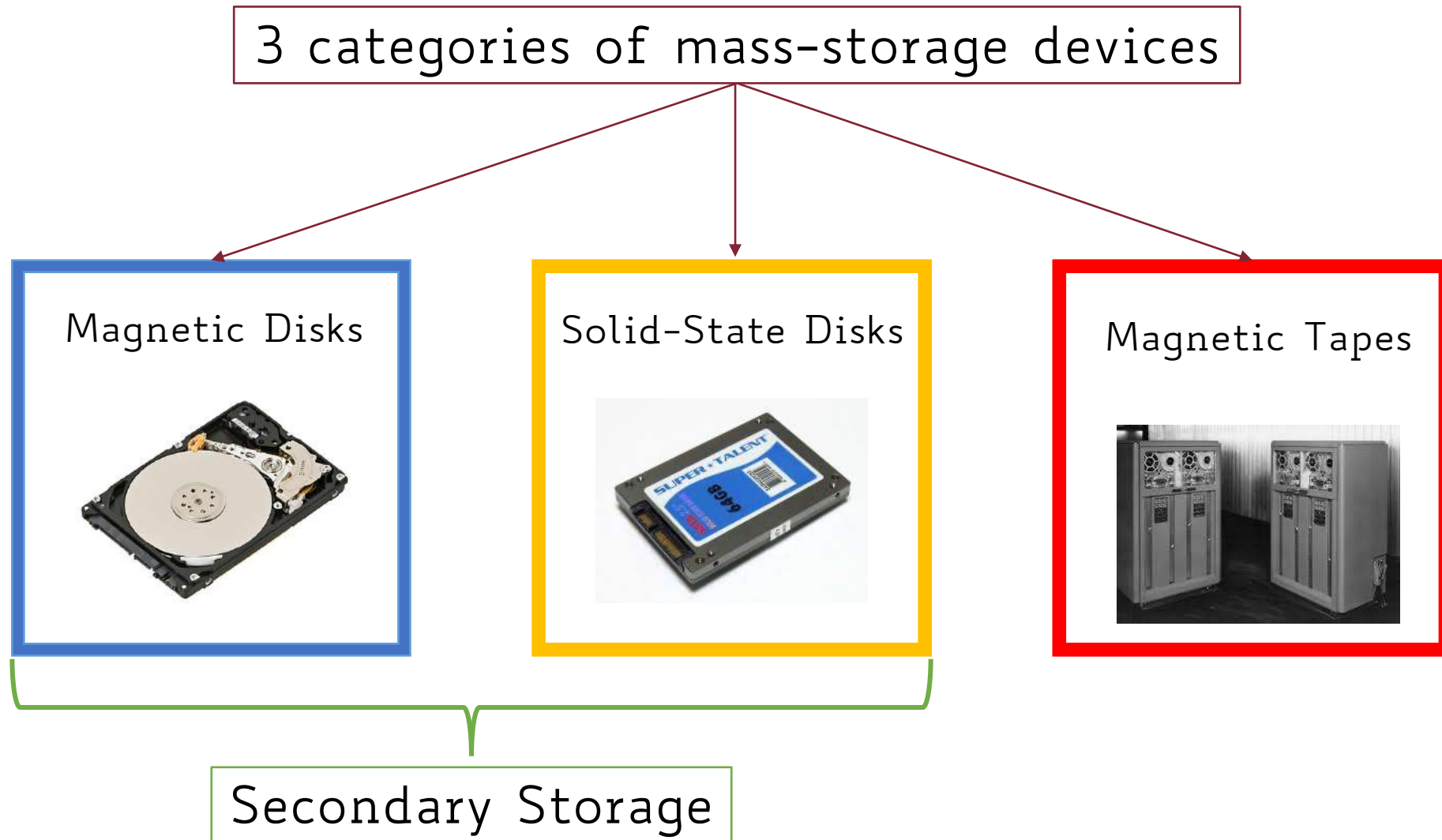
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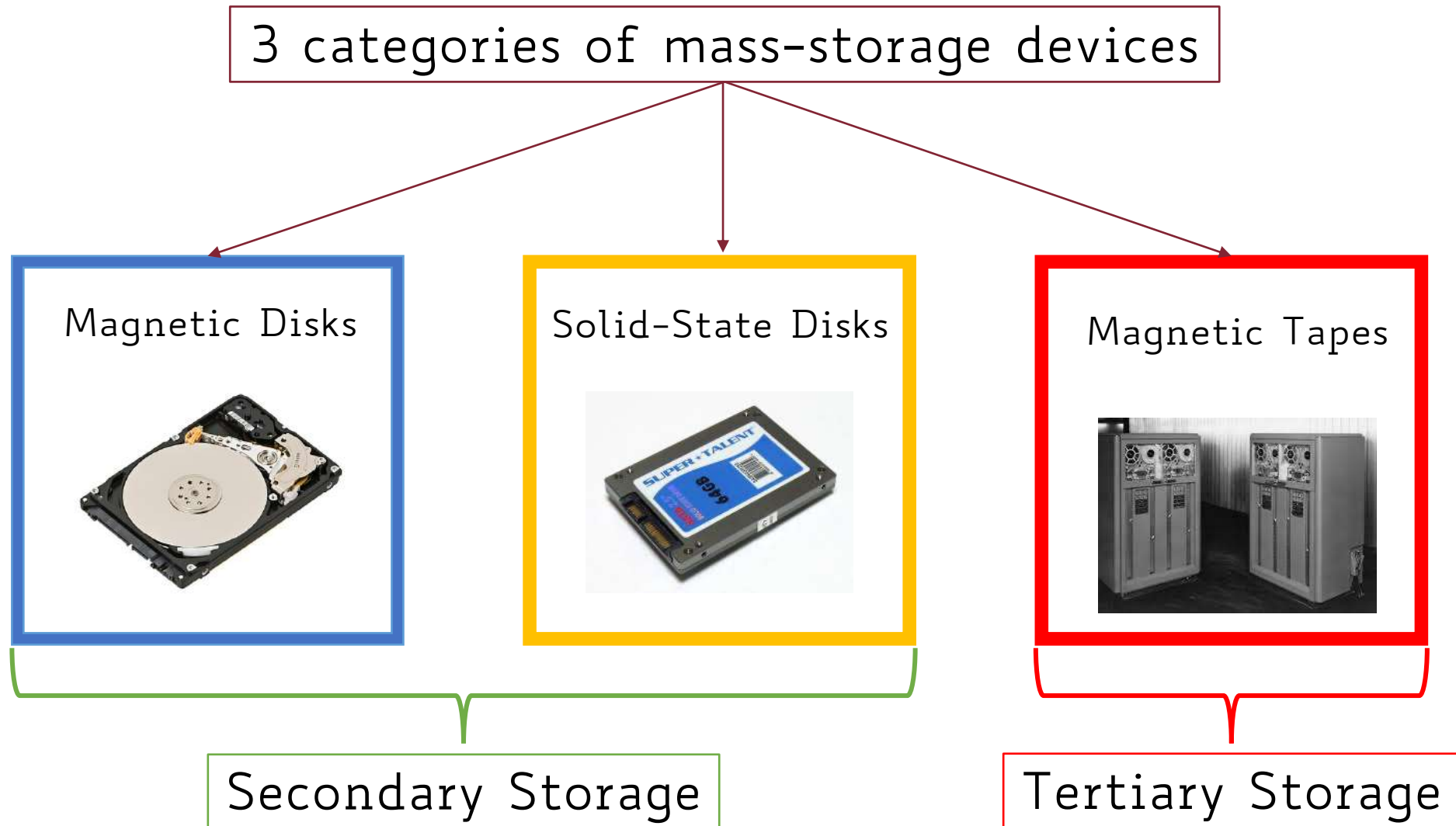
Magnetic Tapes



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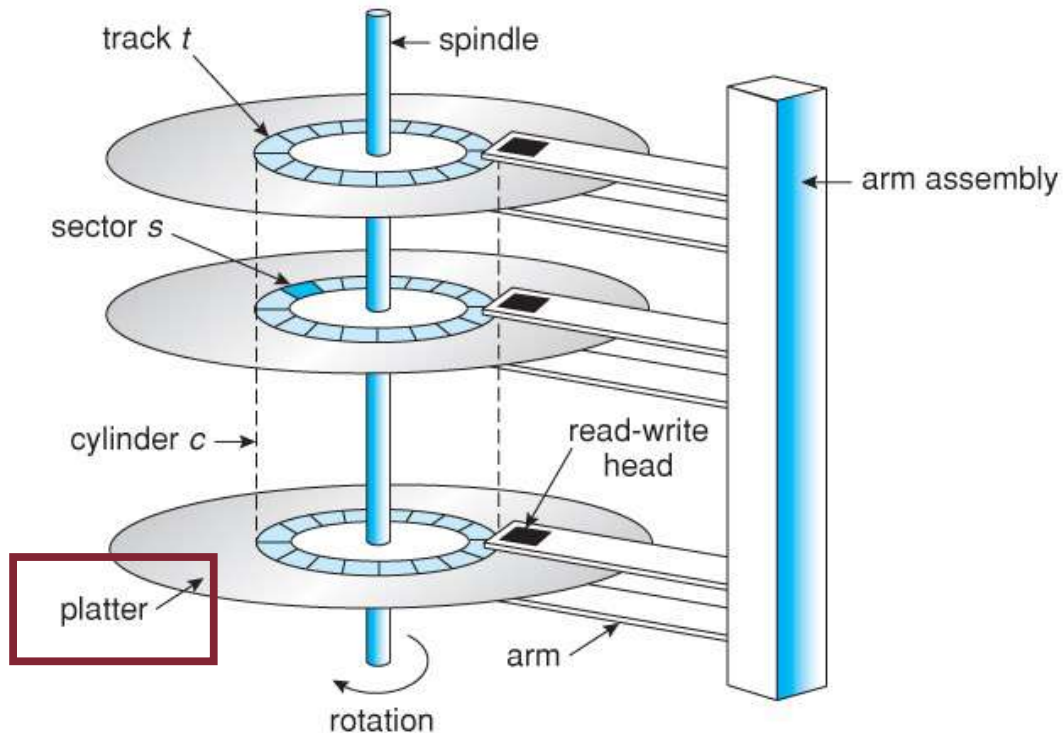


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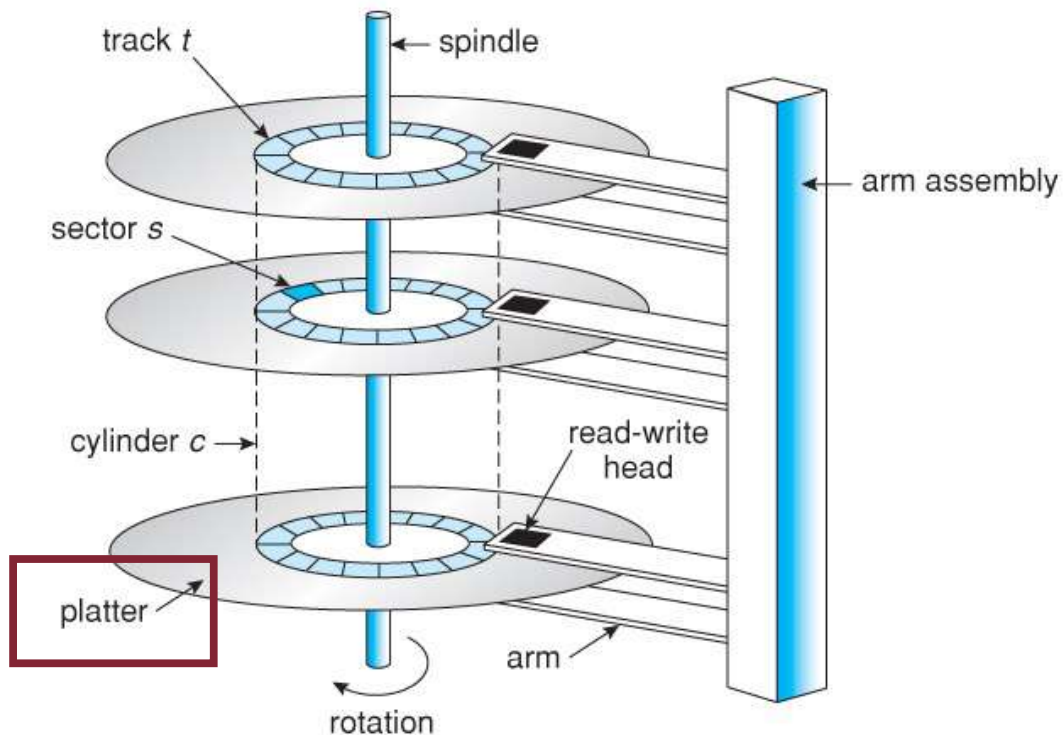


# Magnetic Disks: Structure

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



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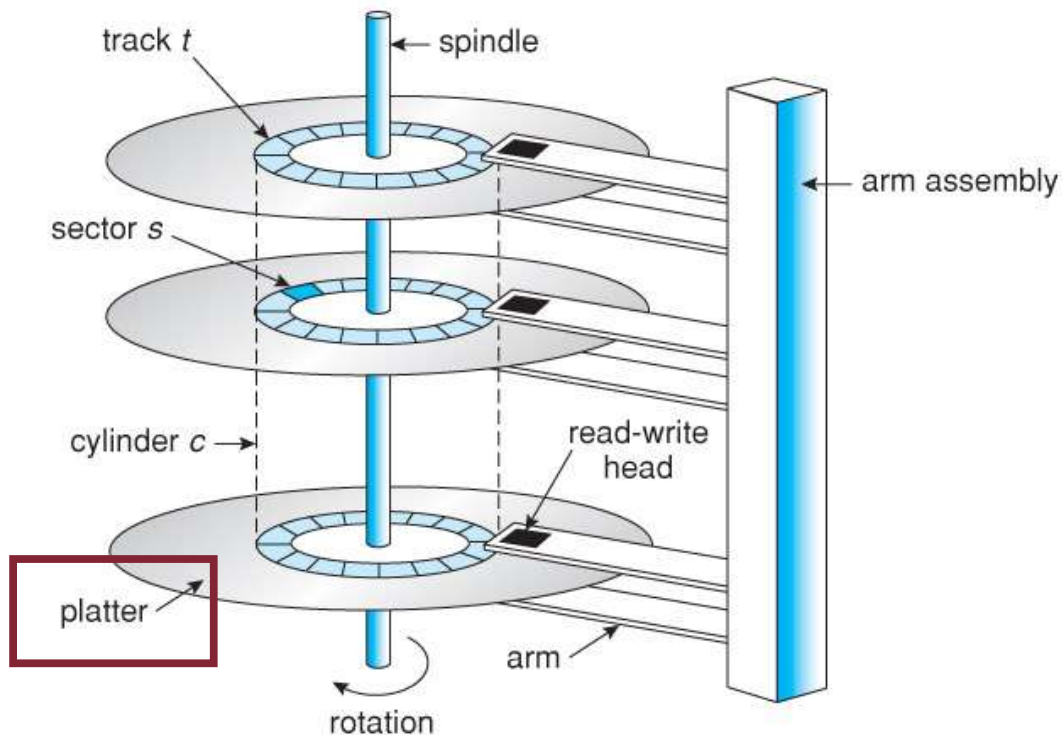


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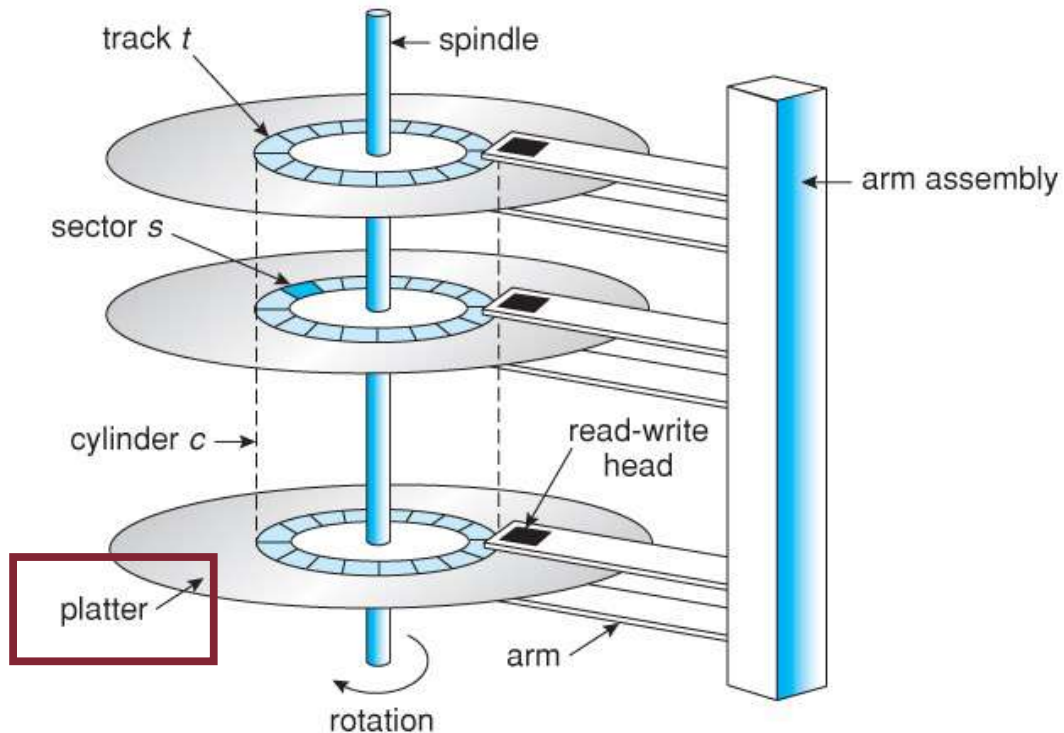


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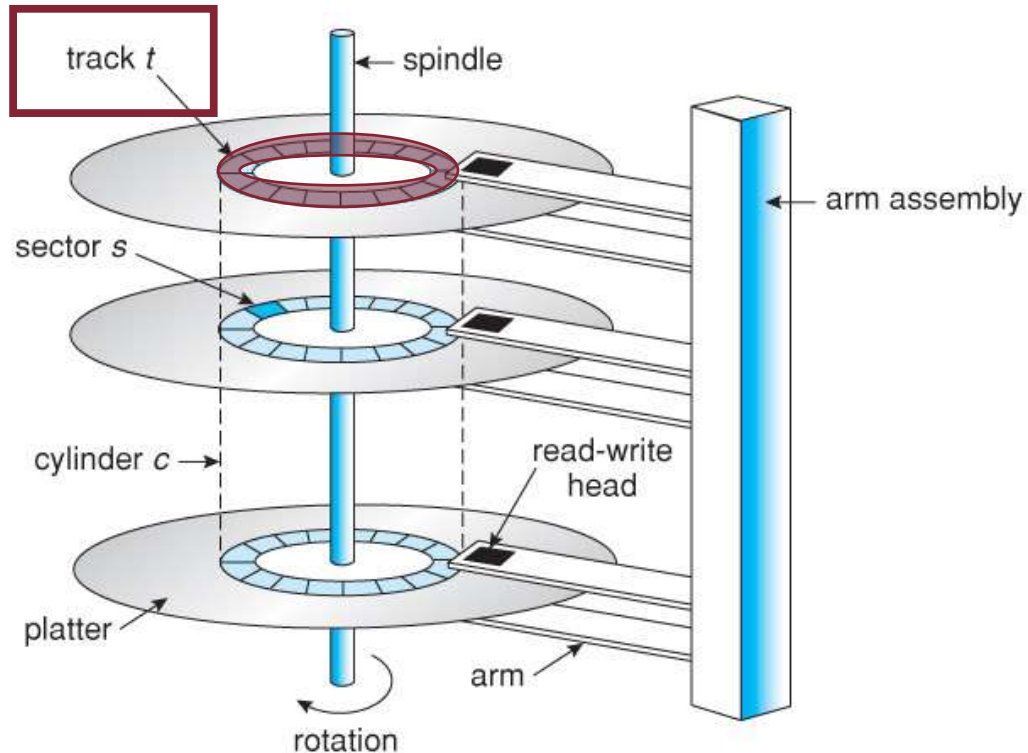
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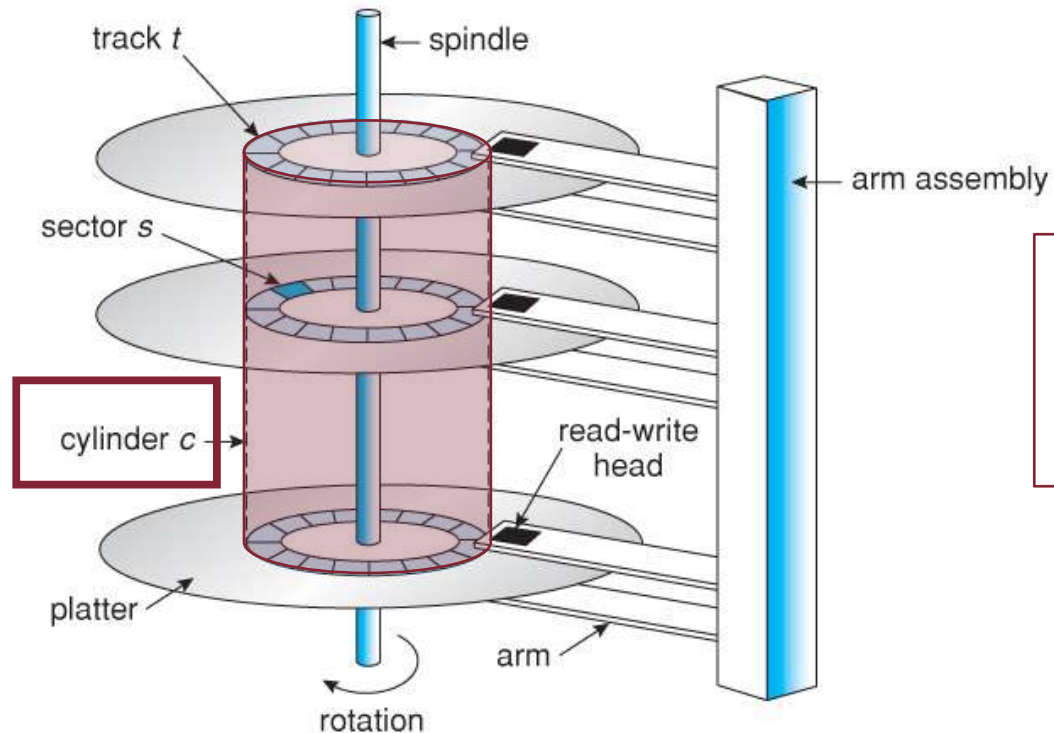
Each platter has **2** working **surfaces**

# Magnetic Disks: Tracks and Cylinders

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



# Magnetic Disks: Tracks and Cylinders

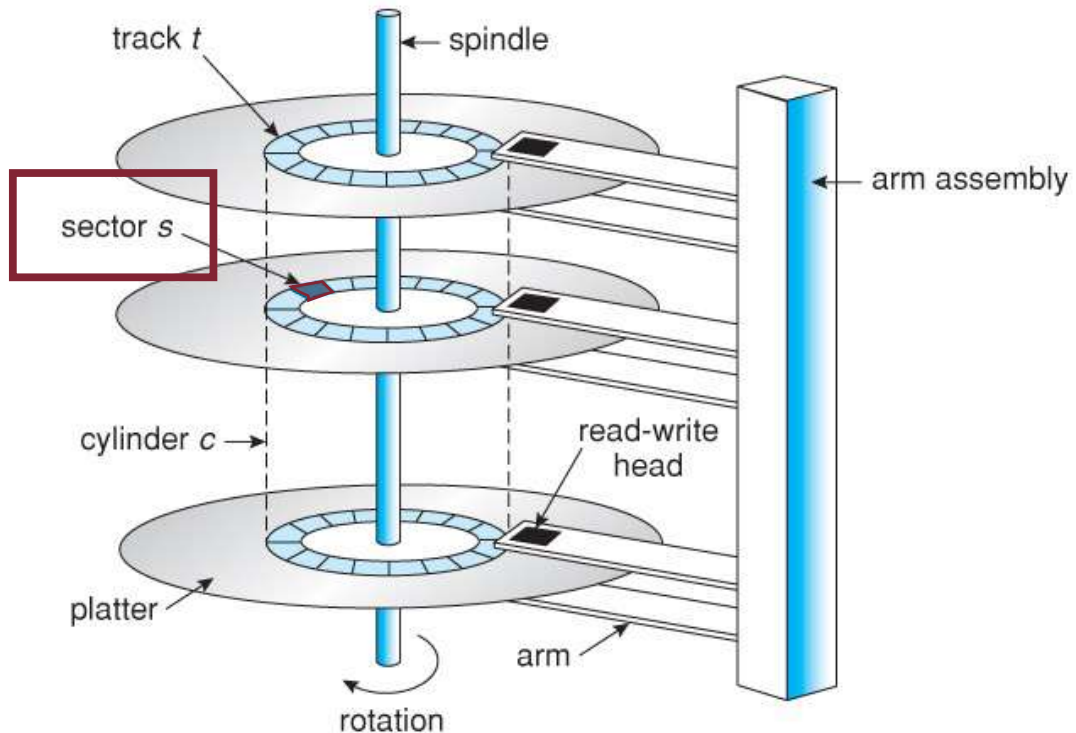


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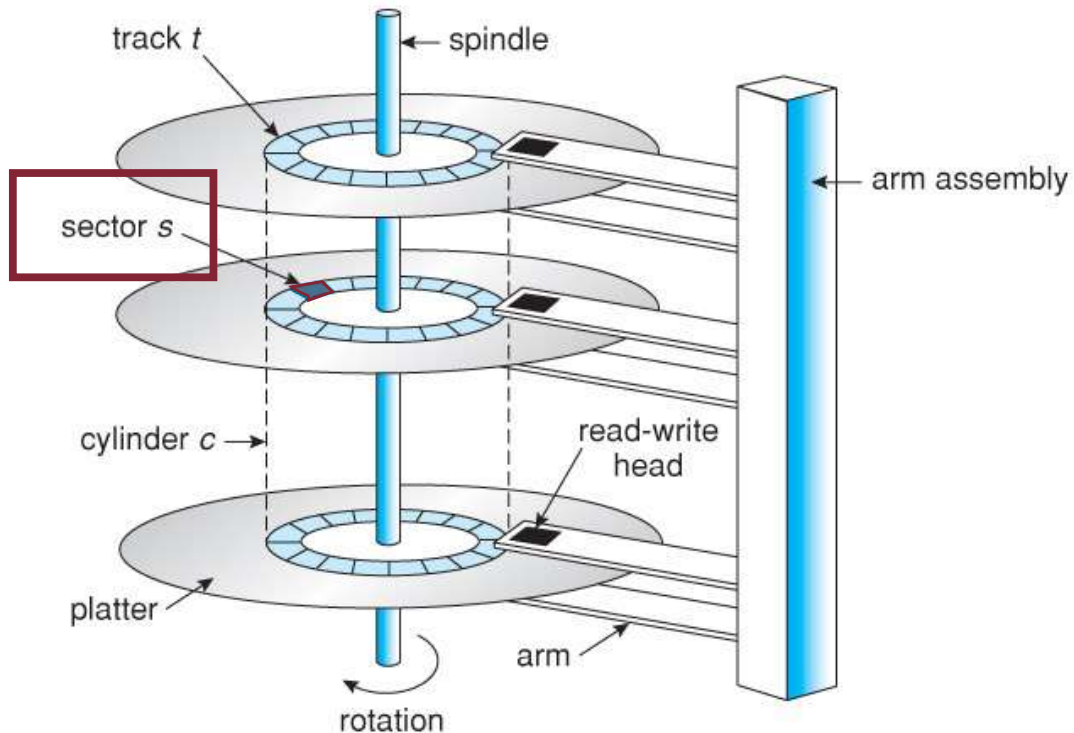
The set of all tracks that are the same distance from the edge of the platter is called a **cylinder**

# Magnetic Disks: Sectors

Each track is further divided into **sectors**



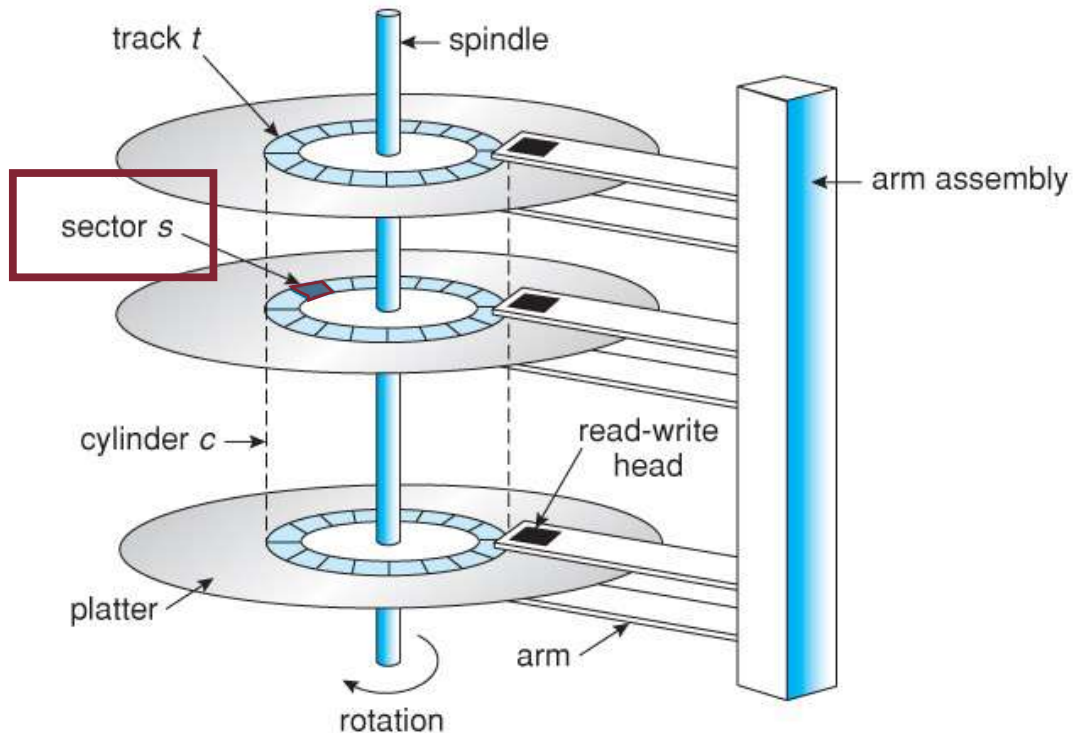
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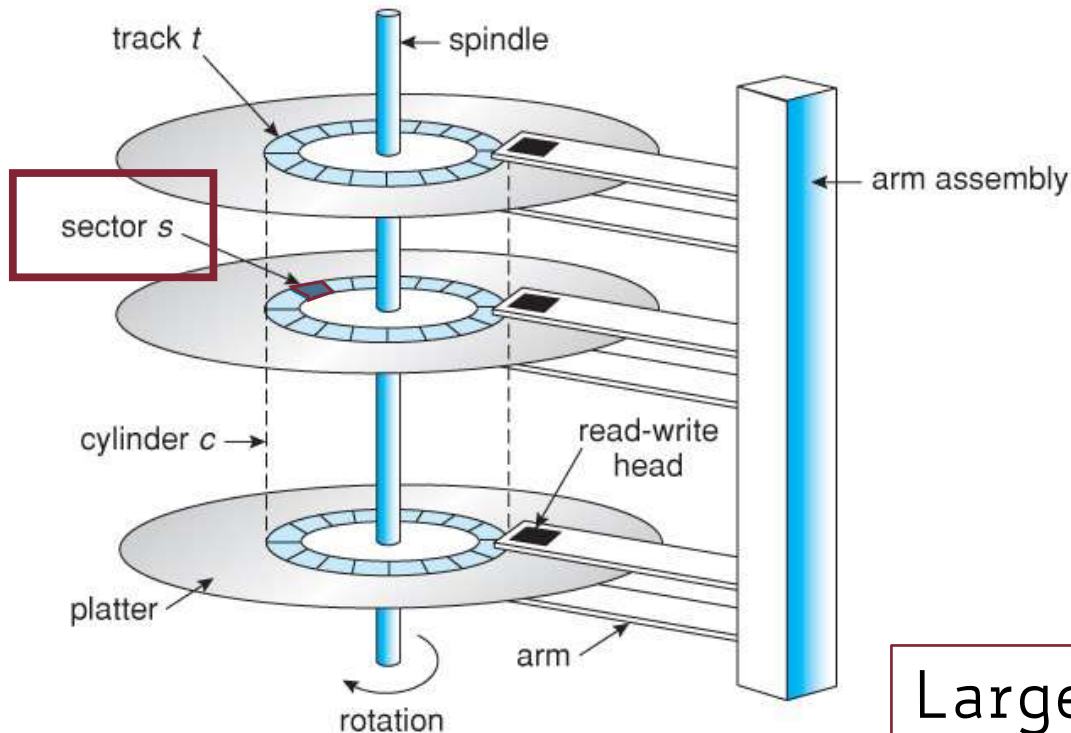


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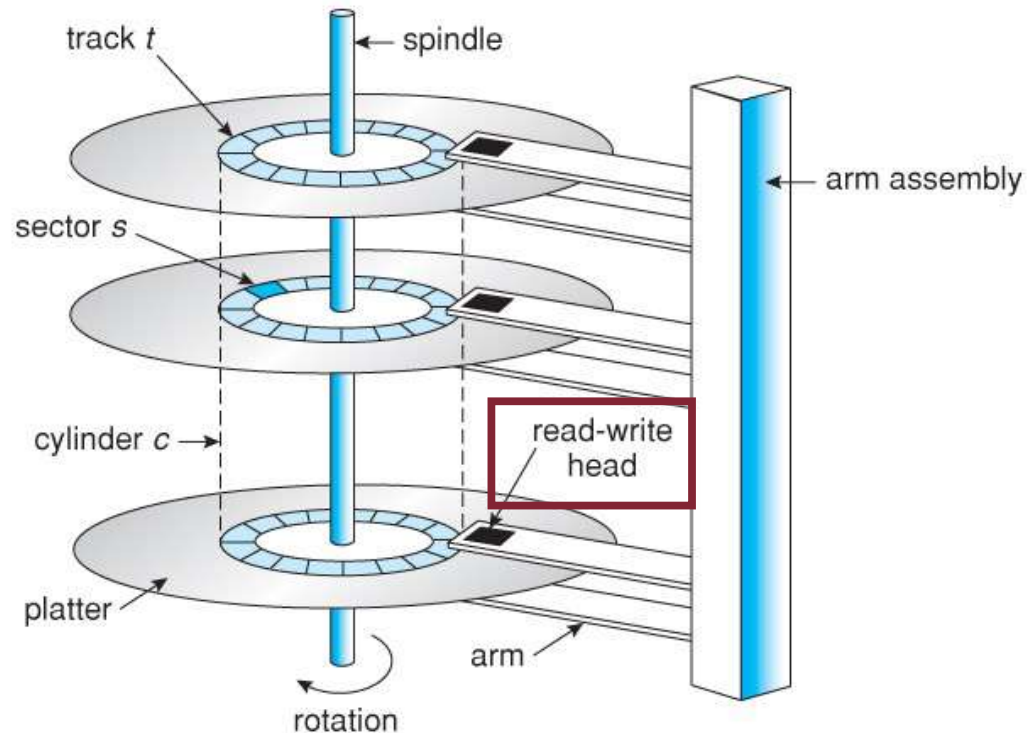
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Larger sector sizes reduce the space wasted by headers and trailers, but increase internal fragmentation

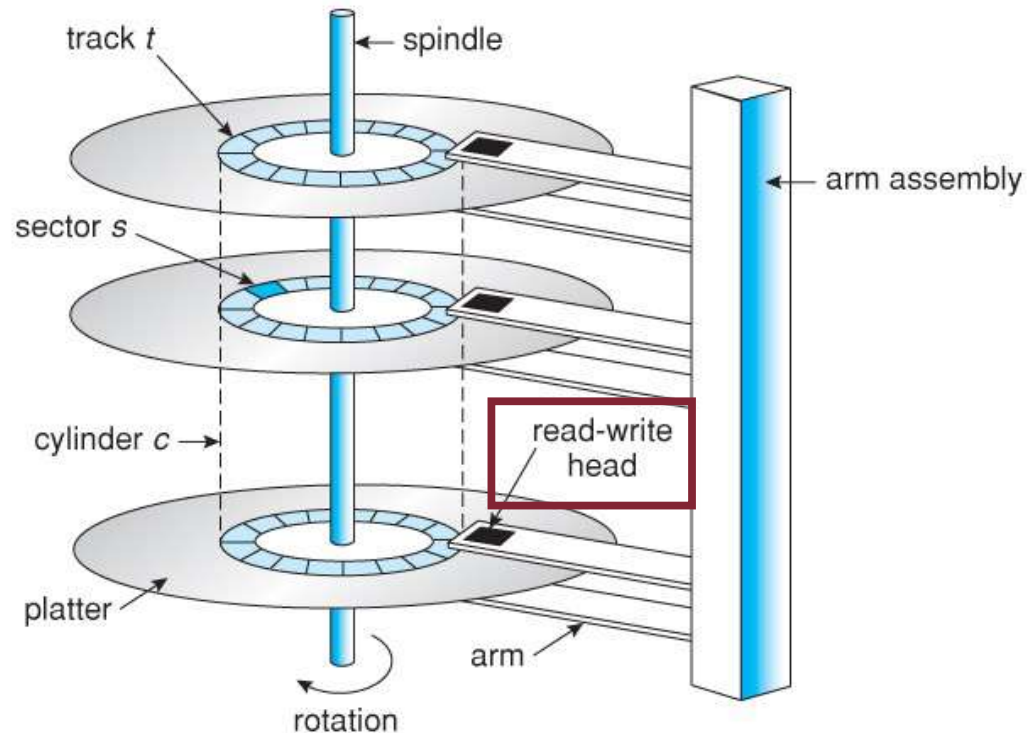


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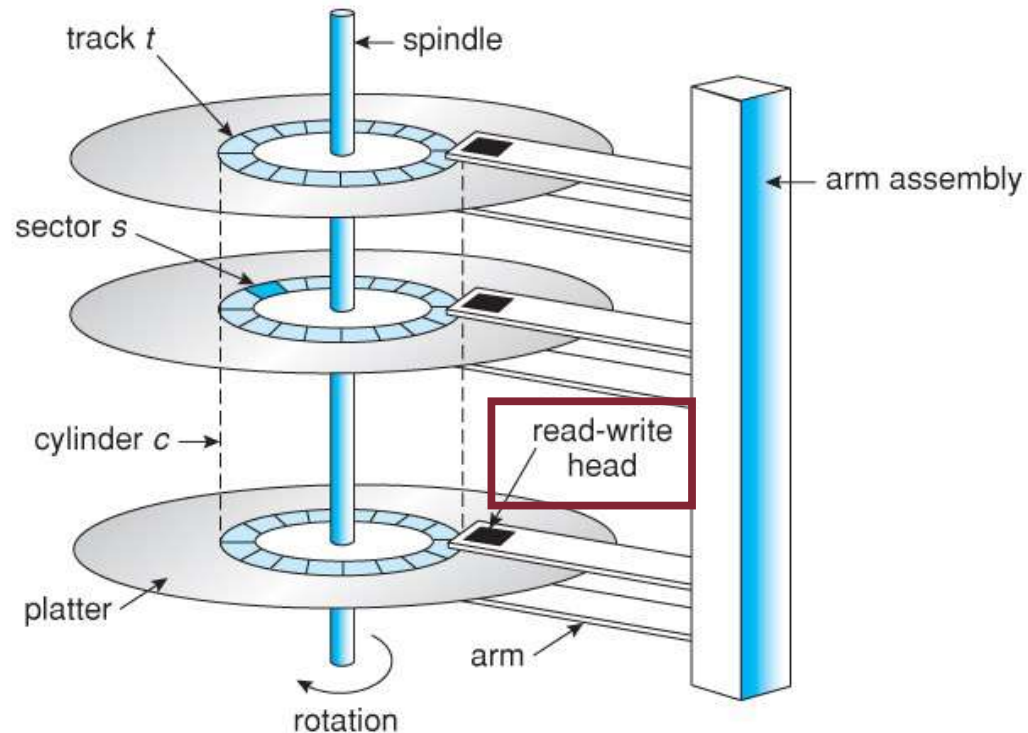
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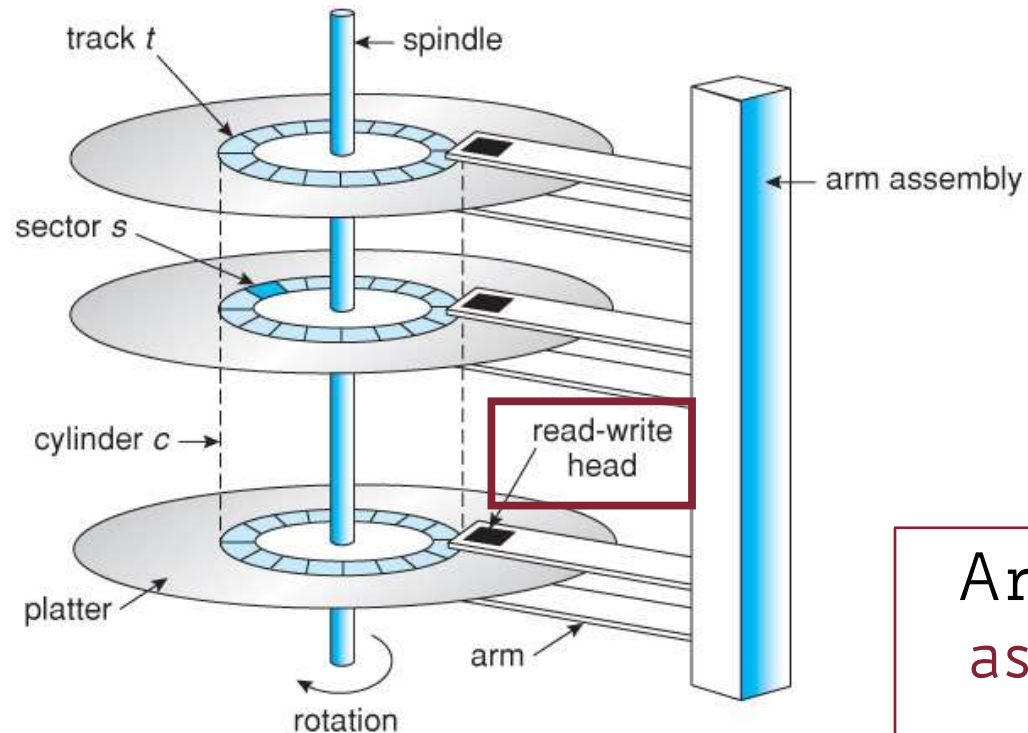


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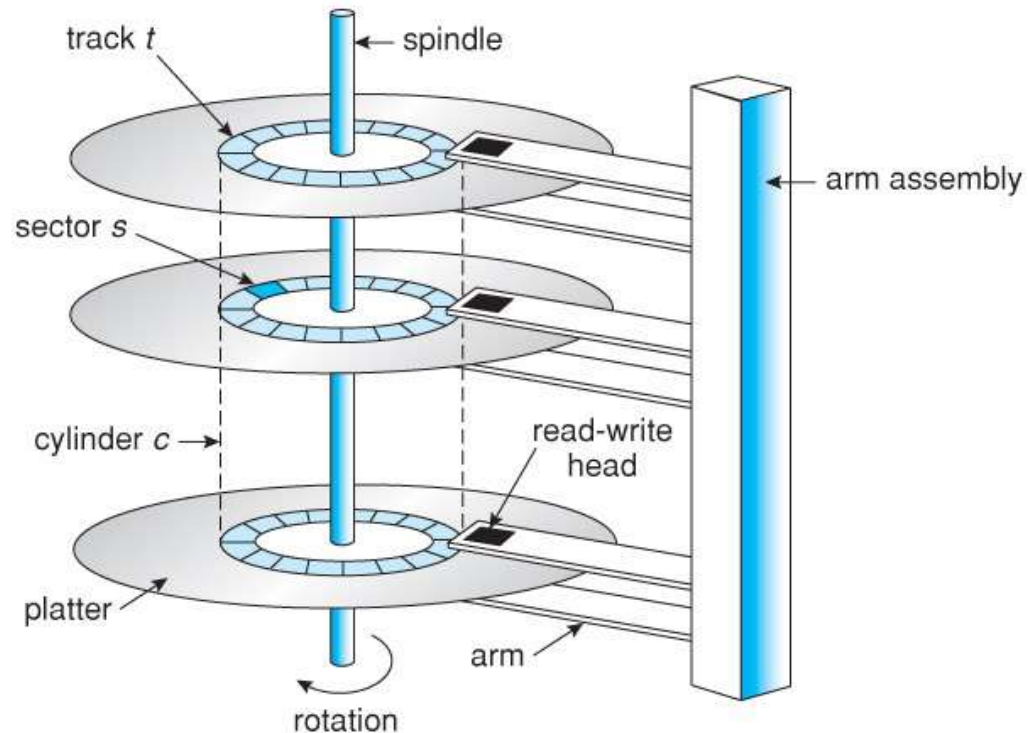
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Each head is placed on a separate **arm**

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

# Magnetic Disks: Storage Capacity

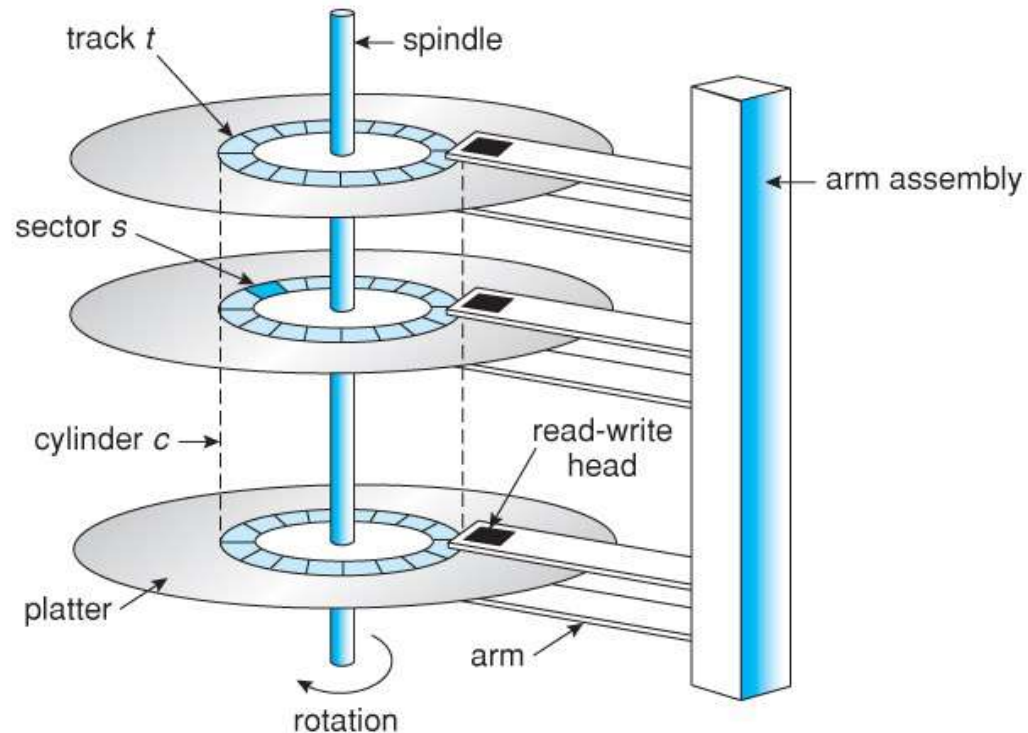
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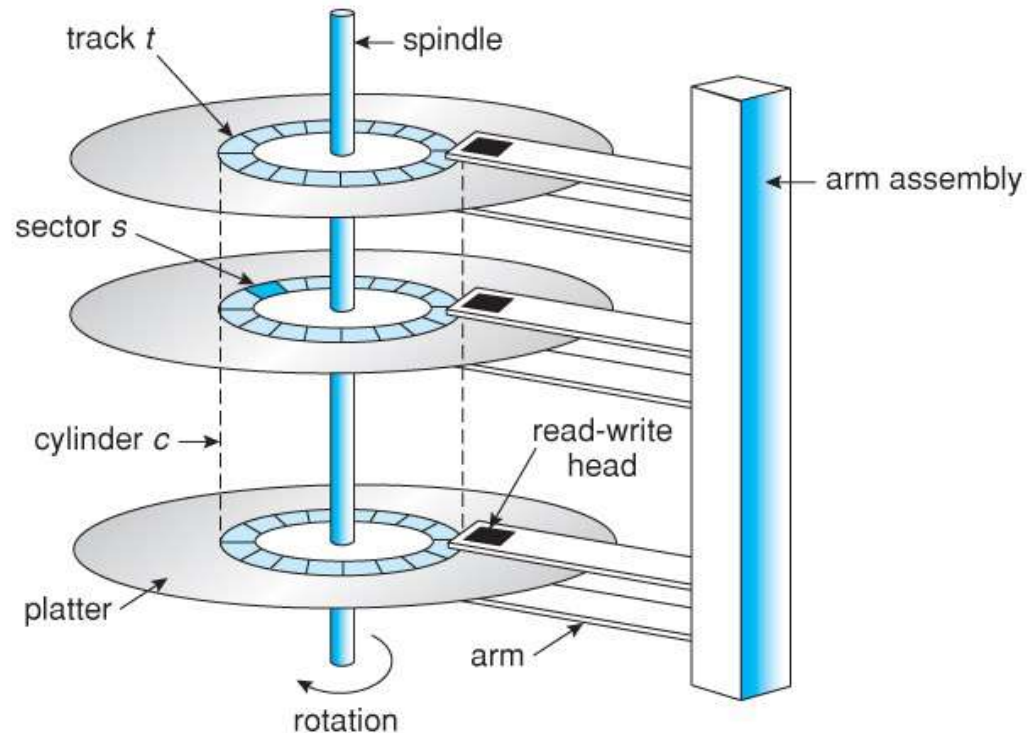
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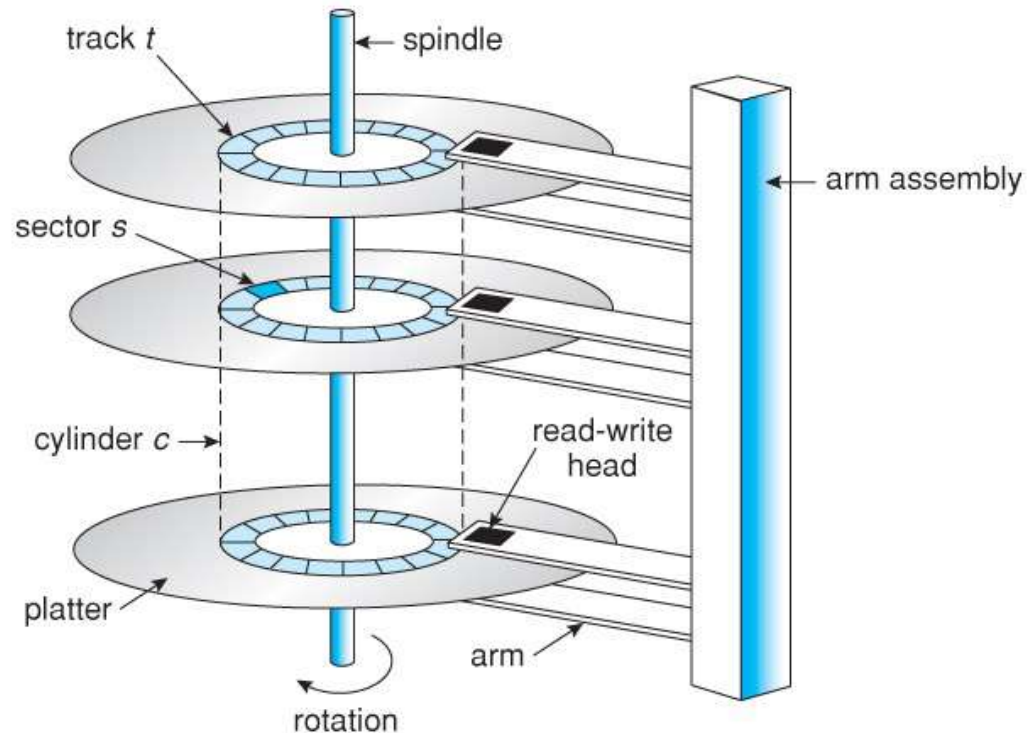


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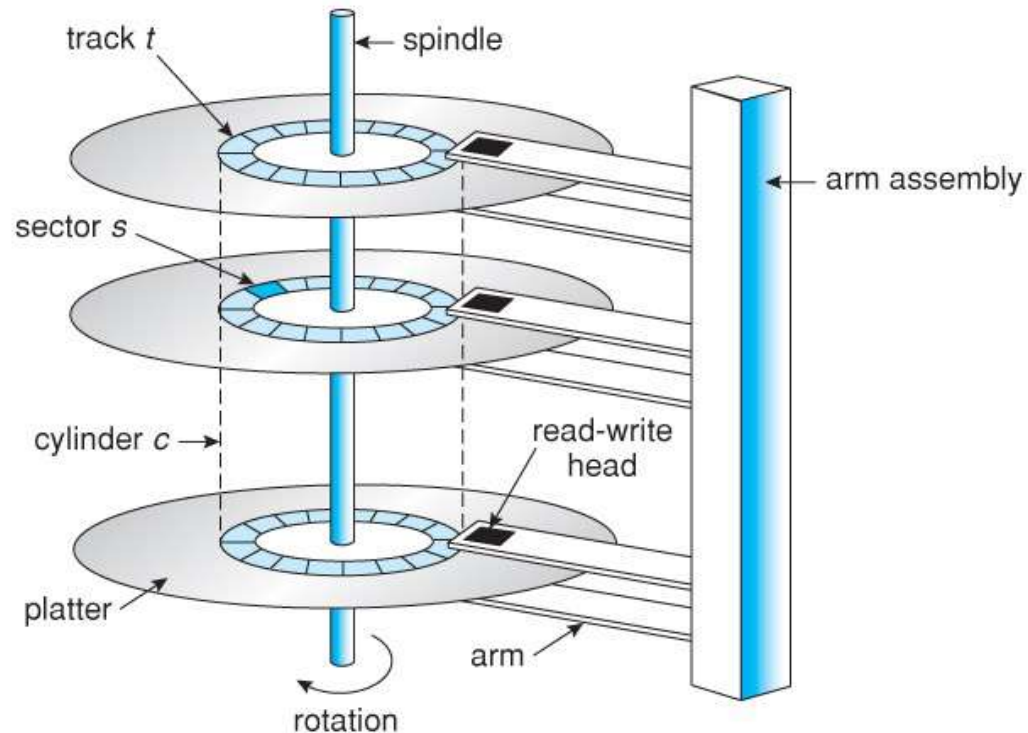
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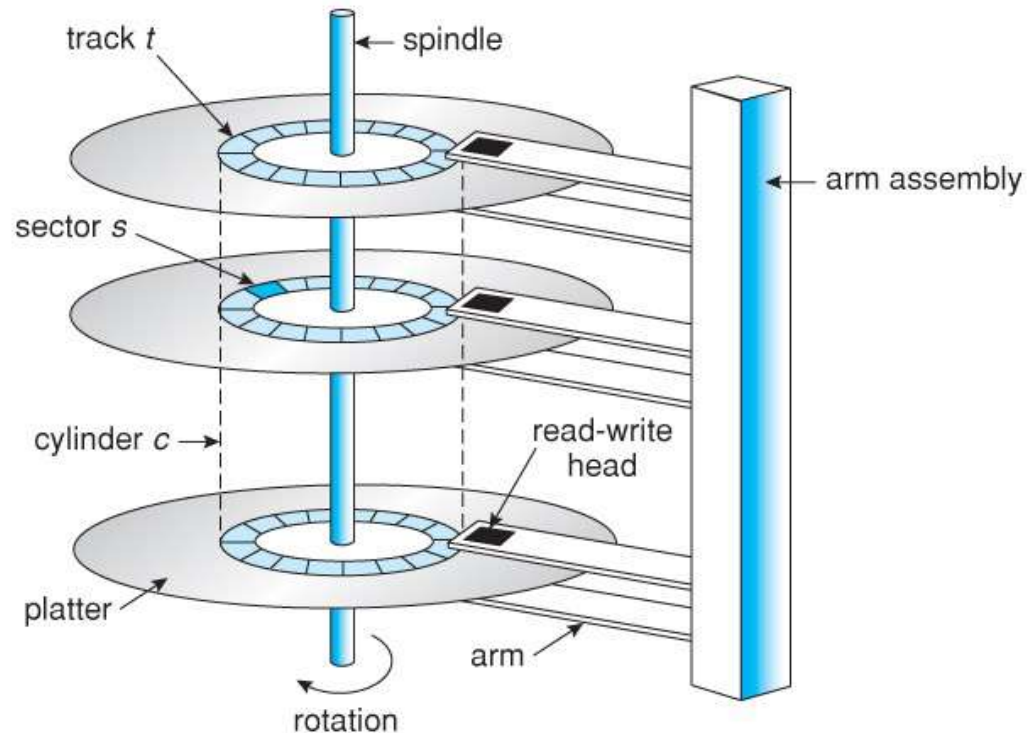
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$$C = H * T * S * B$$

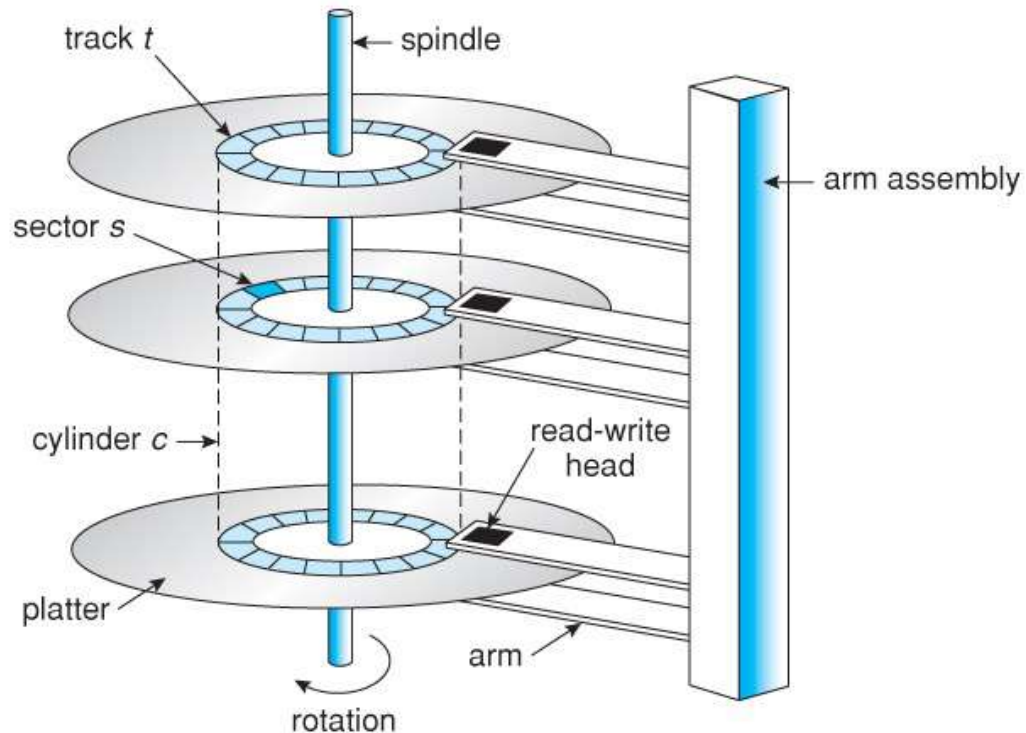
OVERALL CAPACITY

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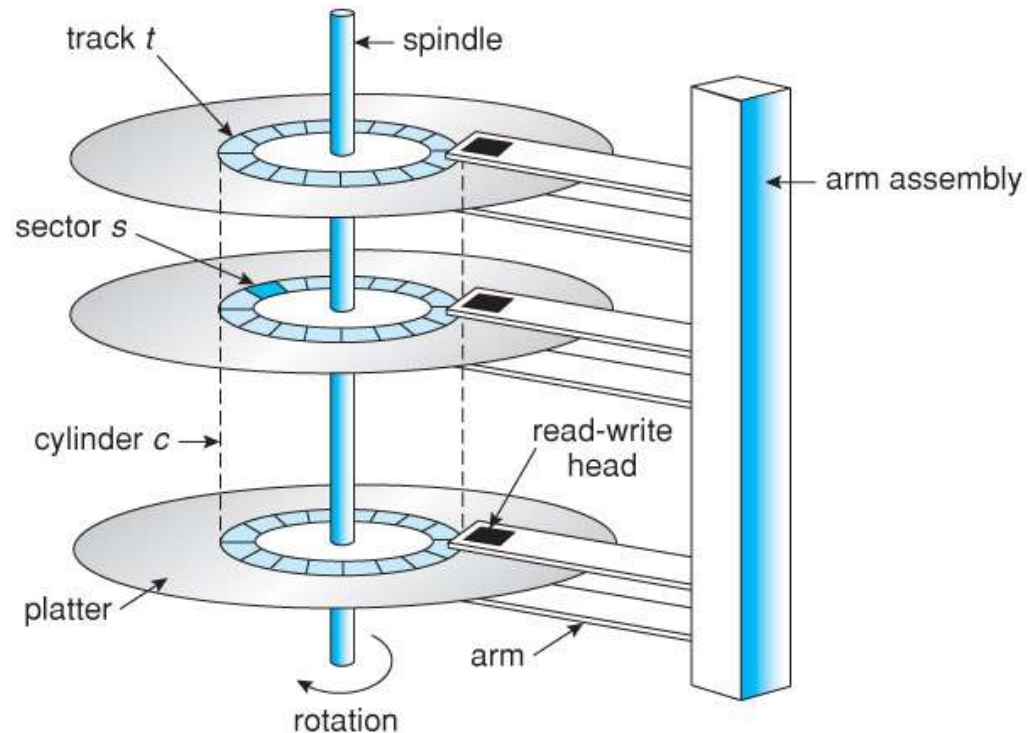
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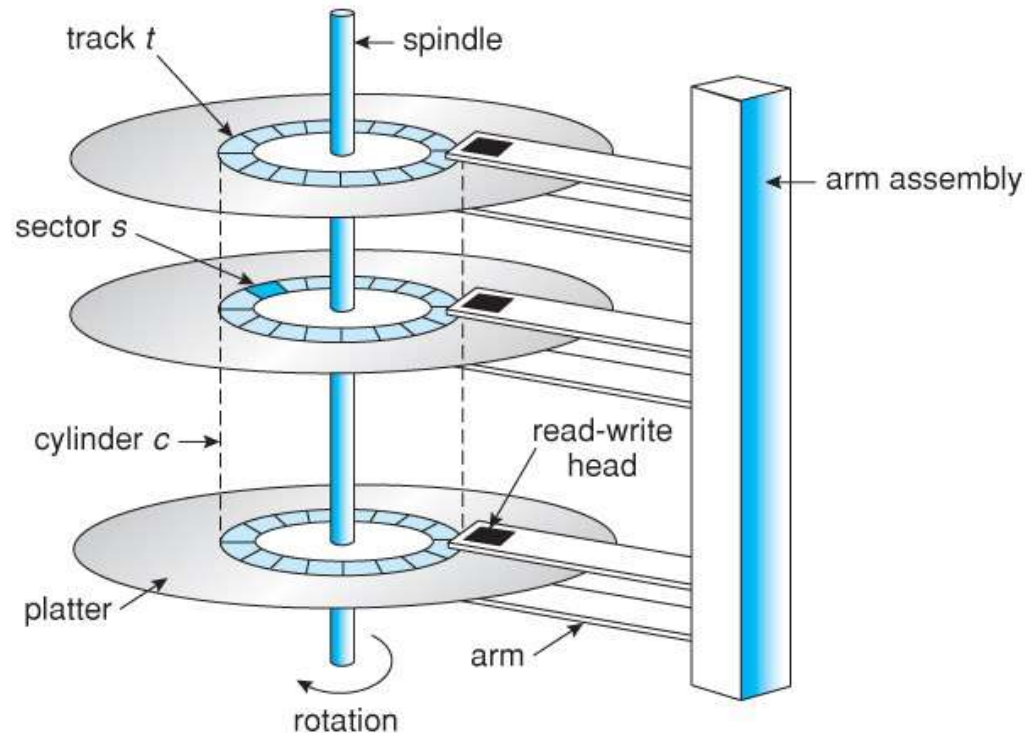


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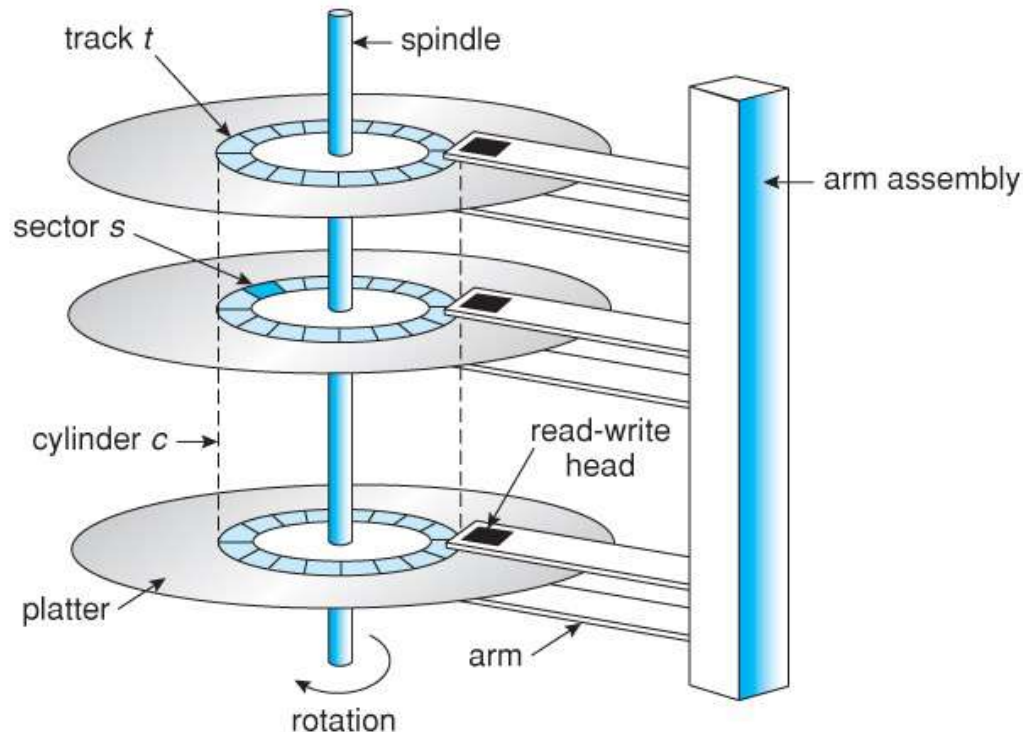
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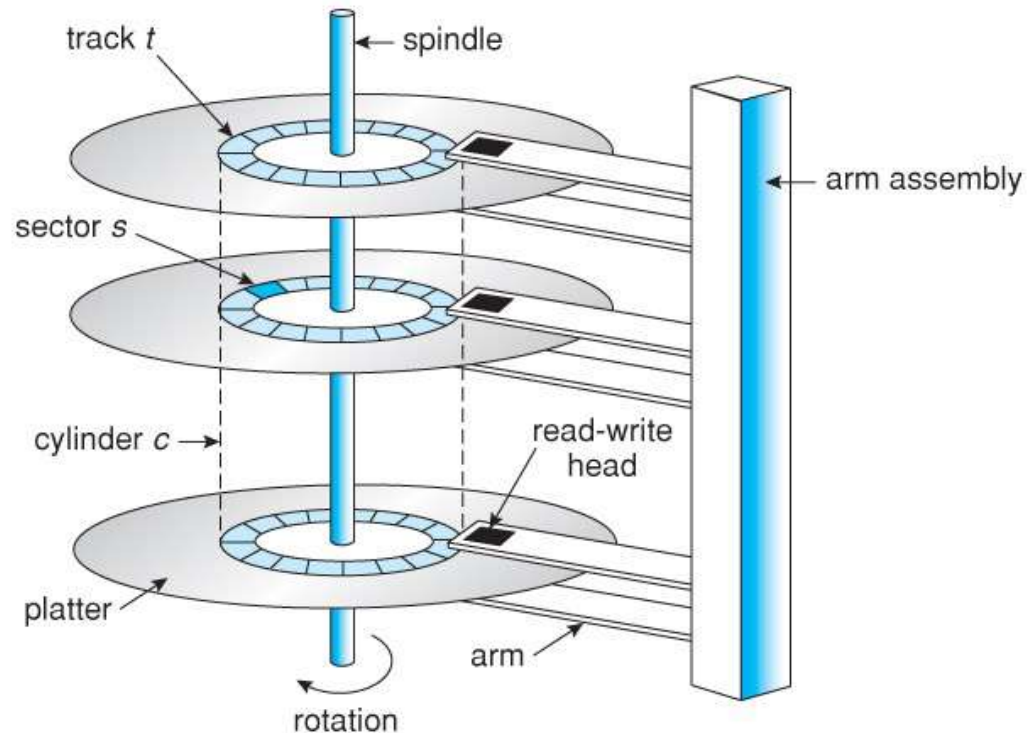
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- Different frequencies and timing from innermost to outermost tracks

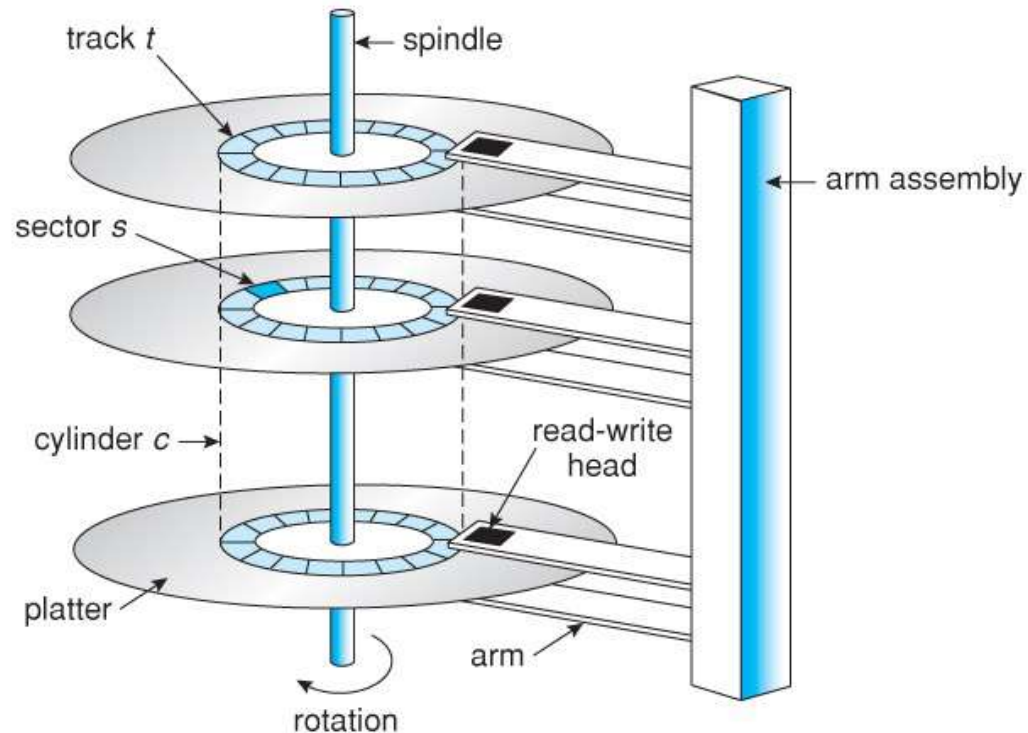
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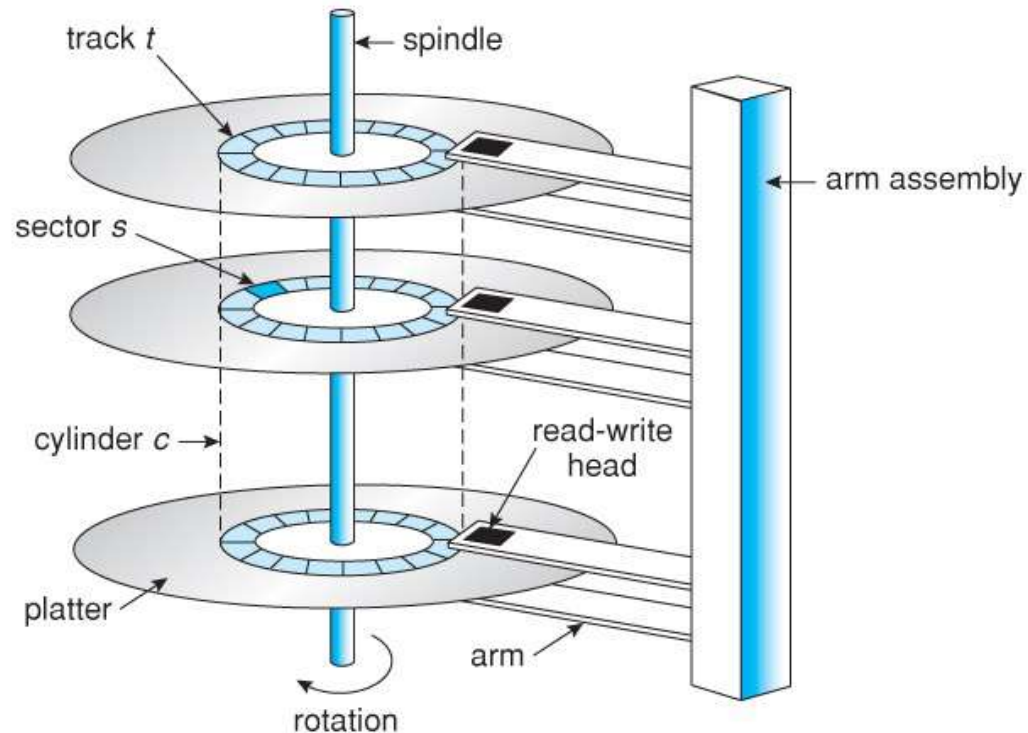


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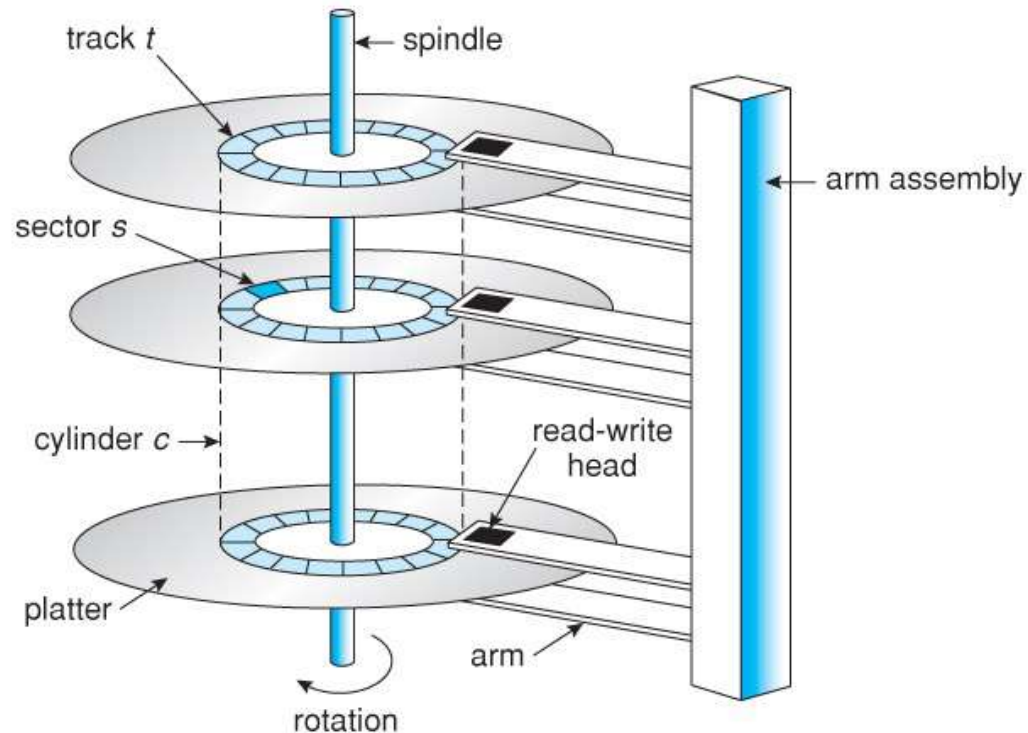


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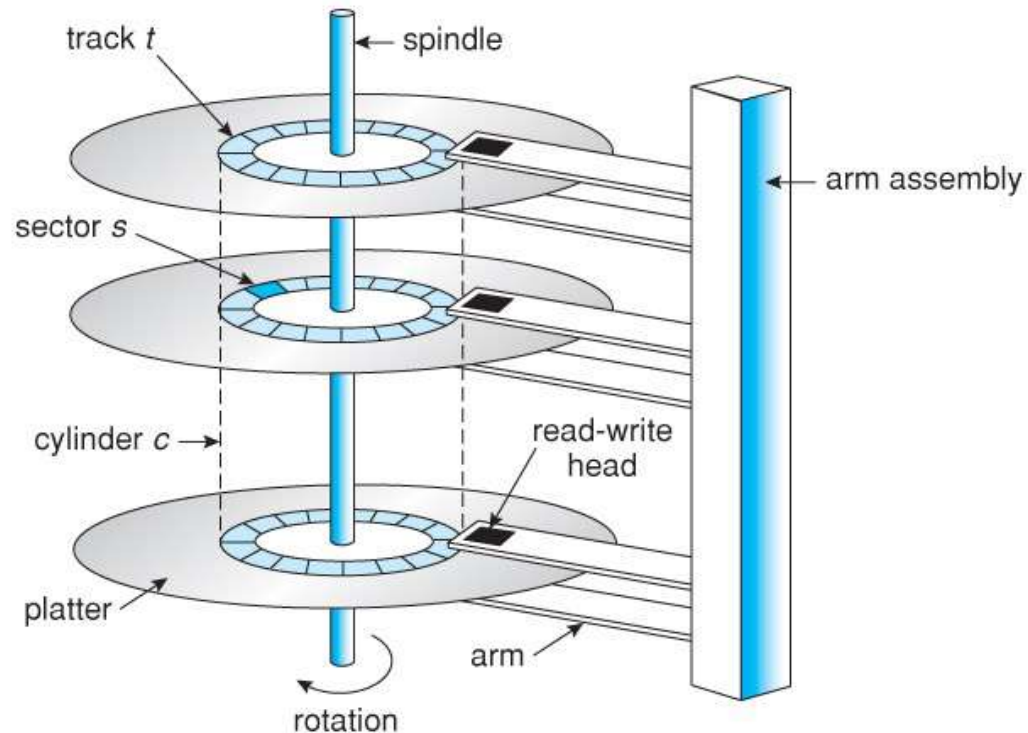
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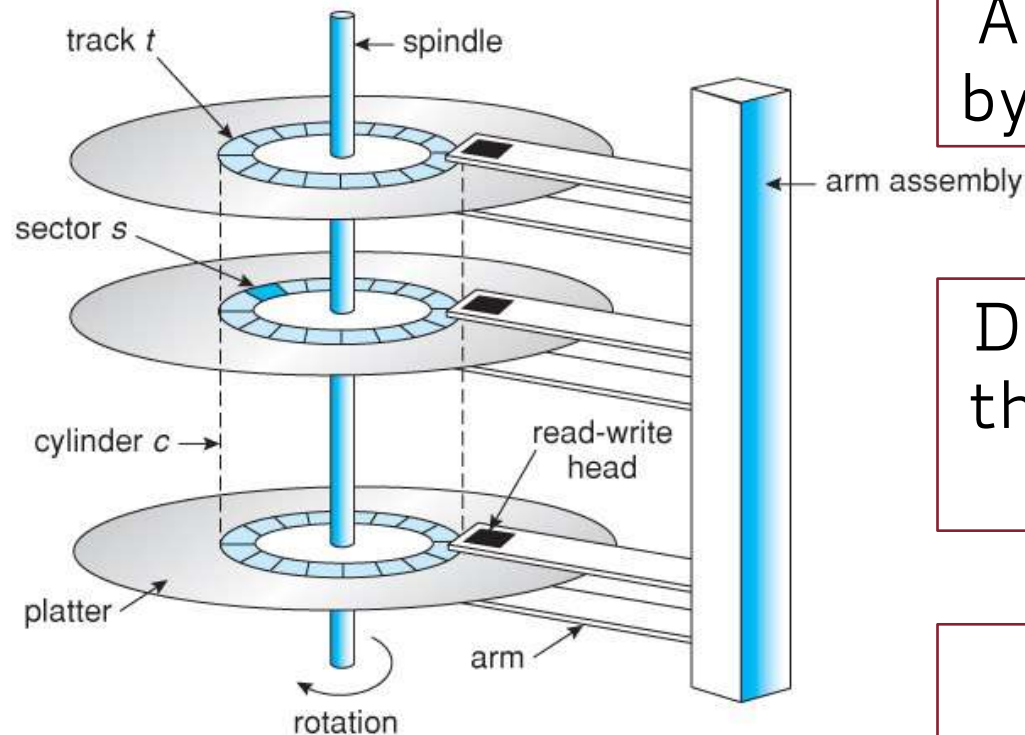
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**Zone Bit Recording (ZBR)**

# 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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- Outer tracks spin **faster** than inner tracks (more sectors traversed in the same amount of time due to larger radius → more sectors per zone in ZBR)

# Magnetic Disks: Data Transfer

- Data transfer from the disk to memory is made of **3 steps**:
  - **positioning time** (seek time or random access time)
  - **rotational delay**
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- Typically, the slowest step in the entire process

Bottleneck of overall disk data transfer

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- On average, **0.5 revolutions** (r)
  - E.g., for a 7200 rpm (120 rps) disk this equals to  $0.5 \text{ r} / 120 \text{ rps}$   
**~4 msec**



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Data Transfer Time = **Seek Time** + Rotational Delay + **Transfer Time**

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

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- Each logical block is the smallest unit of transfer (e.g., **512 bytes**)
- The array of blocks is mapped onto disk sectors sequentially

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- Then through other cylinders (from the outermost to innermost)

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- To avoid such a risk, disk heads are "parked" when the computer is turned off

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- 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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- Finally, data is transferred from that cache to the host controller and the motherboard memory at electronic speeds

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- To minimize data transfer time from disk we need to minimize those



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- Fast-spinning disks → lower rotational delay

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!